AVIATION WEEK AND SPACE TECHNOLOGY

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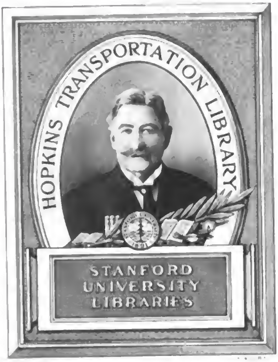

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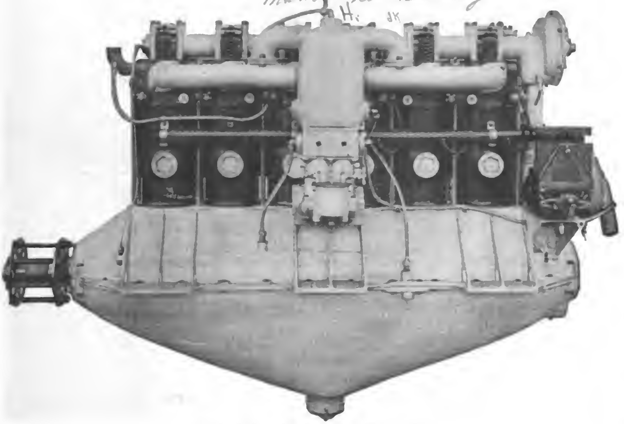

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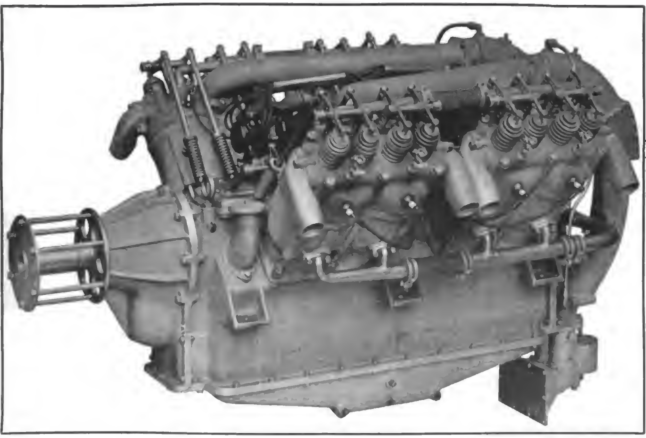

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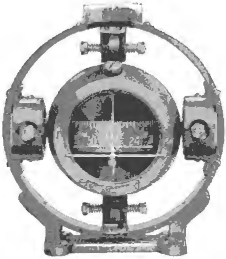

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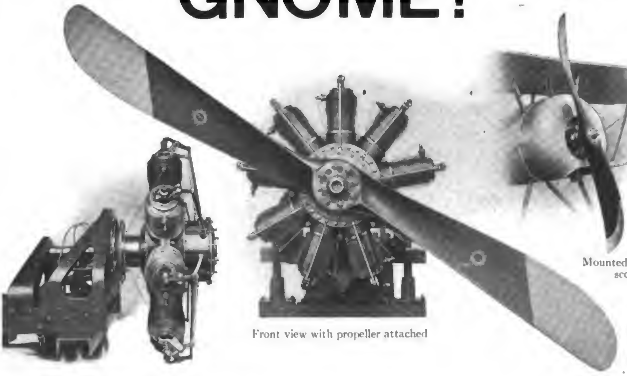

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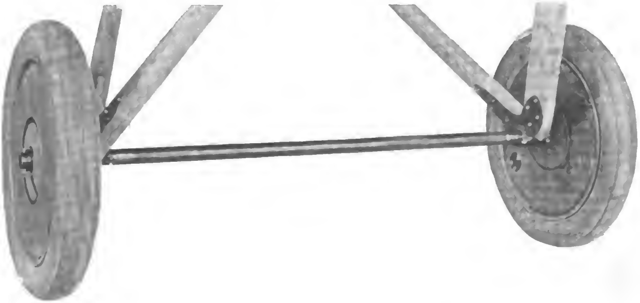

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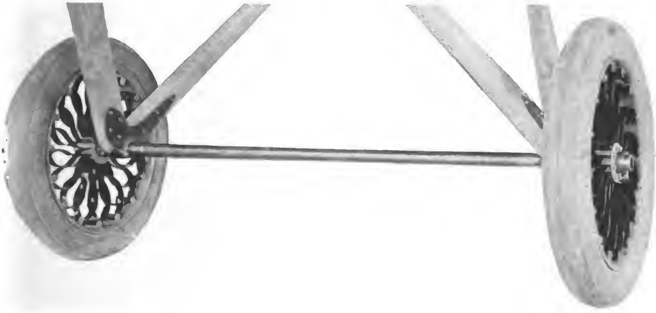

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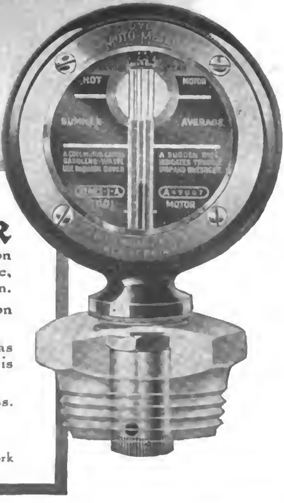

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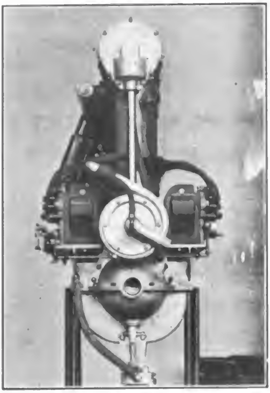

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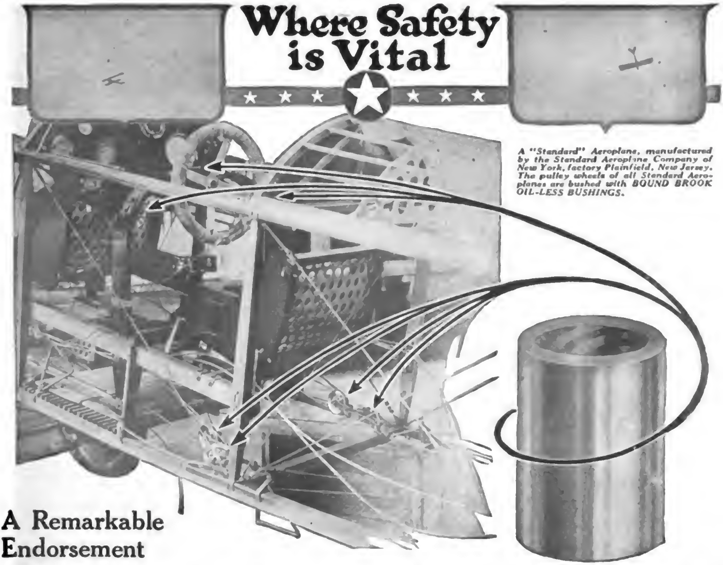

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It is important, therefore, that the many pulley wheels which guide the tiny wires to the different controls should invariably act smoothly, quickly and **surely.**

Should a pulley wheel bushing stick or jam it might spell catastrophe for the operator. Yet these little pulleys are continuously exposed to the action of the elements. At flying heights—18,000 feet at times—the planes repeatedly rush through dripping clouds of rain and moisture. It is vitally important, therefore, that any type of anti-friction bearing which might corrode or rust should not be used for the pulley wheel bushings. Many types of bearings cannot resist corrosion or rust under such conditions. It is impossible to keep them continuously oiled when flying at different angles. Plain bearings, for similar reasons, are objectionable.

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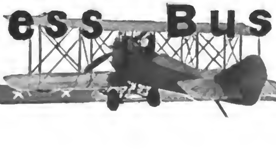

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AUGUST 1, 1917

AVIATION
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VOL. III. NO. 1

Member of the Associated Business Papers

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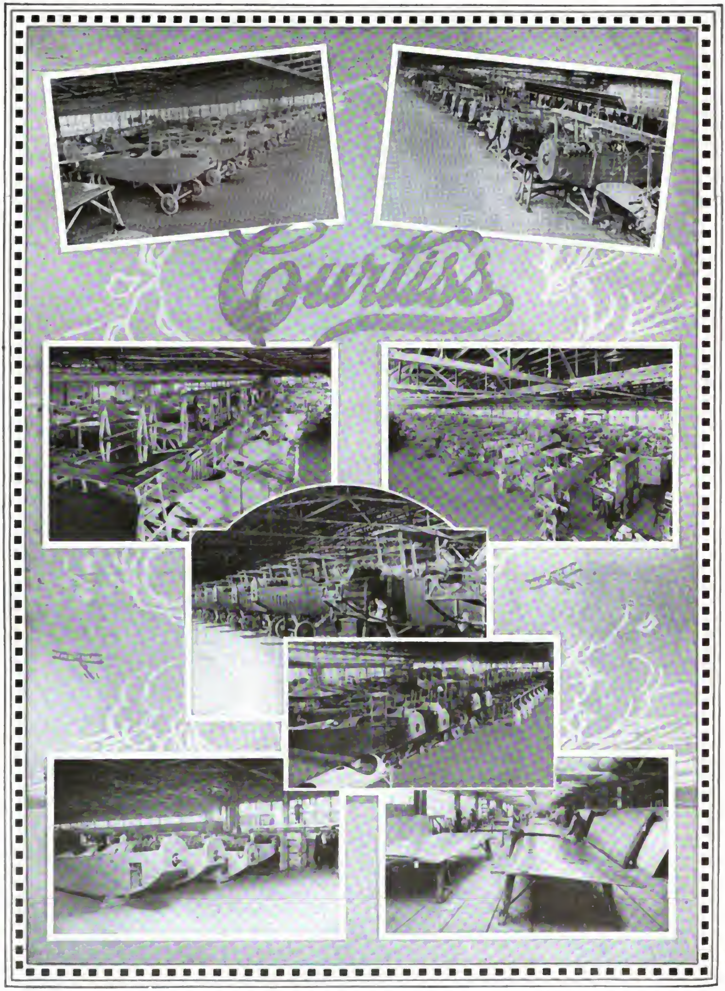

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Instructor in Aeronautics
Massachusetts Institute of Technology

BUSINESS MANAGER
GEORGE NEWBOLD

Vol. III August 1, 1917 No. 1

With this issue Aviation and Aeronautical Engineering enters upon its second year. It would be an impossible task to condense in a short editorial even the most important events which have occurred in aviation during the past twelve months.

A year ago, in this country, military and naval aeronautics were just beginning to be taken seriously. Congress had become convinced that the United States was one of the weakest powers in the world in the air, and that due attention to this important and newest branch of national defense had been neglected. A start was made with appropriations for the Army and Navy, which now seem ridiculously small. The amount set aside, however, was large enough to enable constructors of airplanes and engines to be given small orders and receive more or less encouragement from the Government, and not have to rely entirely upon foreign orders to keep their business going.

The creation of an Aviation Section of the Signal Corps with Brig.-Gen. George O. Squier at its head was also an important factor in the rapid development of military aeronautics in this country. Gen. Squier has had the imagination to grasp the magnitude of the air service which the country must have in order to play a successful part in the war, and to deliver the final thrust at Germany through the air. To him, perhaps more than to any other man, is due the success of the program which has just been approved by Congress and the President. His earnest and convincing testimony before the Congressional committees holding hearings on the aviation bills, did more to enlighten and inform the members of the committees than any other single feature.

The Aircraft Production Board and its chairman, Howard E. Coffin, have also been of the greatest importance in the work of creating a favorable public sentiment, and the importance of the work of this Board in assisting to put into effect the plans of the Chief Signal Officer cannot be overestimated.

By its statements to the public and by the effective and continuous publicity of the Aero Club of America, the people of this country have been aroused to the needs of an adequate air offensive in the war.

The Navy with its usual policy of silence has prepared a program which will lay a foundation for a naval flying corps for coast defense, submarine searching and scouting. Many sites for stations have been selected and rapid progress is being made in erecting the necessary buildings and supplying flying equipment. Experimental work is also under way which may produce types of airplanes peculiarly adapted to naval work.

The work of the officers of the Allied commissions now in this country should also be praised. These experts have done much more to assist in our work than will be realized until after the war is over. They came to this country armed with facts and figures, which were used where they would do the greatest good, and their sincerity and earnestness have impressed all with whom they have come into contact.

The airplane industry in this country has found itself at last; it has organized and through the joint action and cooperation of its members has solved many of the difficult problems which have been obstacles in the past. The industry with a fine spirit has been assisting the new concerns which have been called on to aid in the production of airplanes and engines.

Congress, in passing the $640,000,000 aviation bill without prolonged debate, has rendered our allies a real service. Representatives and Senators have with a unanimity which is unique in the history of large appropriations, given their wholehearted support to this bill, the President signed it immediately, and Gen. Squier and his staff now have available an adequate amount with which to make a beginning of providing the United States with an air fleet worthy of the country.

The Patent Situation Settled

The cross-licensing agreement which has been entered into by the aircraft manufacturers is a long step toward progress in clearing the way for rapid expansion and freedom of action. It is a matter of congratulation that litigation has been avoided at this time. The National Advisory Committee for Aeronautics, which has been instrumental in helping the adjustment of difficulties among patentees, has done a remarkable piece of work very quietly. The effects of this settlement will also be to bind the aircraft manufacturers closer together, as the arrangement as made involves financial considerations which will eventually run into the millions. Now, any patentee with an improvement which is of value to the industry, can have his patent used and receive compensation therefor which will be just and equitable.

The Next Volume

Despite the fact that the censorship of news is properly becoming more and more strict, Aviation and Aeronautical Engineering believes that during the coming year the technical information which it can supply to readers will be practical and helpful. A mass of engineering data which has never been published and which can have no effect in a military or naval sense is becoming available and will be of the greatest use to constructors and designers.

The Type F Dirigibles of the Societá Leonardo da Vinci

The "F" type of dirigible belongs to the semi-rigid class. Its main characteristic features are:

Double envelope.
Gas envelope fitted with transverse and longitunal diaphragms.
Rigid truss girder running in the direction from stern to bow.
Axial suspension of the girder from the balloon.
Arrangement of the car close to the envelope and rigid suspension of the same from the truss or reinforced girder.
Stiff bow, the bow stiffening being solid with the reinforced girder
Flexible steering surfaces of grate-like construction.
Splitting of the propelling apparatus in quite independent sets.
Screw-propellers with adjustable reversible pitch.
Upper platform fitted with shaft (or pit) and ladder for connection with the car.

The present summary description of the above arrangements is illustrated in the drawing, Fig. 11, showing the 15,000 cu. m. F 4 dirigible, that was built recently and passed through its contract trials most successfully.

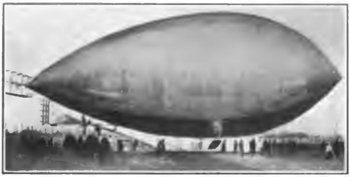


Fig. 1 An Early Type, the Leonardo da Vinci F1

Double Envelope

The envelope of the "F" dirigible consists of an inner or gas envelope and of an outer one that surrounds the former completely, a continuous and entirely free air space being left between the two. This space, the bottom portion of which forms the air compensation chamber, is maintained under pressure while traveling. Owing to this arrangement:

(a) The gas envelope is efficiently protected against the heat and chemical action of the sun's rays, a most important condition for airships intended to travel at high altitudes during daytime;
(b) The gas envelope is relieved from all stresses due to the sailing velocity, these stresses being taken by the outer envelope;
(c) The outer envelope, being a plain air-tight construction, can be made very light, even when it has to withstand relatively high internal pressures (high velocity dirigibles);
(d) The external form of the dirigibles is a regular one and therewith free from additional head resistances. Further the external form is not materially altered when any compartment of the gas bag gets emptied and the airship can sail on regularly in case of damage to the gas envelope.

The outer envelope is plain varnished silk and, in order to prevent the danger of large gashes being formed, it is strengthened by a large number of closely set longitudinal and circumferential bands fitted to its inner surface. Suitable arrangements are provided for connecting the inner and outer envelopes with one another and for maintaining them in their correct relative position.

The outer envelope is connected by two catenary bands to the underside of the truss girder and thus actively contributes, when it is under pressure, to the general rigidity of the whole airship.

The bottom of the outer envelope can be readily opened longitudinally and tucked up for the purpose of inspecting and repairing the girder, the suspension means and gas envelope.

Partitioned Gas Envelope

The inner or gas envelope is fitted with gas-tight cross diaphrams, by which it is divided into numerous, independent gas-proof-compartments. These transverse diaphragms intersect eight longitudinal, likewise gas-tight, partitions radiating from the geometrical axis of the airship and reaching to the outer surface of the gas envelope.

Along the center line, where the longitudinal partitions meet, a strong axial band is thus formed. This band is called "the suspension band" owing to the fact that the rigid girder is suspended from it by a rope system. Thanks to this arrangement:

(a) The gas mass is subdivided into numerous compartments and efficiently checked; so that the stability remains a good one even during the descent from high altitudes;
(b) The cross section of the envelope remains practically invariable in its upper portion whatever be the condition of inflation. This condition, which means that the airship is no longer subjected to increases of its height, greatly facilitates the connection of the two envelopes with the girder as well as the arrangement of the upper platform and of the shaft connecting the latter with the car.
(c) The canvas stresses, which as already stated are due only to the static pressure of the gas mass inside of it, are very small and thus allow of the envelope being made relatively very light. To the attainment of this most important result are contributing also the double envelope arrangment and all the constructural details of the airship.

The gas envelope is made entirely of silk, plain natural silk being used for the longitudinal partitions, plain gummed and varnished silk for the cross diaphragms, double diagonal gummed and varnished silk for the outer envelope and ninefold for the axial or suspension band. The use of silk canvas, gummed by a process enabling its final proof-making by varnishing is a specialty of the Societá Leonardo da Vinci.

The described general construction of the envelope allows an arrangement of operating ropes radiating from the axial or suspension band. The efficiency of so arranged control ropes when maneuvering from the ground is actually noteworthy and far better than when the rope attachment lies below the center line of the airship, as is the case in other dirigibles.

Each gas compartment is fitted with all the necessary mountings, the main one being the gas relief valve. These valves, of which there is one for each compartment, serve both as safety and as control valves; for the former purpose they are directly operated by the canvas of the bottom portion of the envelope through a rope; for the latter purpose they are operated pneumatically.

In order to inflate the airship, the gas envelope is spread out on the ground and the outer envelope fixed on it by provisional ties. While inflating, the envelope is held in place by means of ballast bags suspended from hooks provided for this purpose and suitably spaced along the equatorial line of the envelope; the inflation is therefore effected in quite a similar manner to that of Drachen balloons. When the envelope is a little more than half filled, it is suffered to rise sufficient for slipping the rigid girder under it; the envelope is then secured to the girder and the filling pursued and completed. The operation is easy and quick to perform.

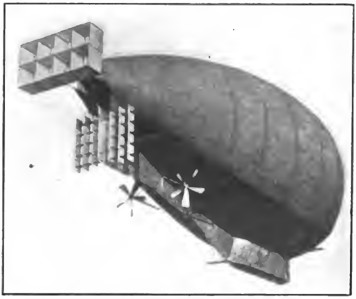


Fig. 2 An Early Type, the Leonardo da Vinci F1

Truss Girder

This is an entirely rigid lattice girder running from end to end of the airship, and arranged between the two halves into which the bottom portion of the gas envelope is divided. Nearly the whole girder length remains inside of the outer envelope, whose shape it approximately suits.

The girder is built up of steel tubes braced with diagonal steel wires or wire ropes, and serves to support the car, rudders, bow stiffening ropes and eventually also the rigid bottom section of the shaft connecting the upper platform and the car.

This girder is designed to stand, not only all the static and dynamic stresses that may set in under ordinary sailing conditions, but also any stresses that may arise from pitching or uneven distribution of load consequent on any of the gas compartments becoming untight and letting out the gas. With a view to fulfilling this condition, which is of paramount importance in Army airships, the main girder has been made rigid throughout.

Axial Suspension

The connection between the girder and the envelope is effected by means of wire-rope sets leading in pairs from the junction knots in the upper side of the girder to the under side of the suspension or axial band, the bottom edge of the band consisting of a series of small catenaries.

The ropes of the suspension system show a very pronounced inclination to the vertical in order to secure the connection remaining unaltered, notwithstanding the heaviest pitching.

In addition to the main connection just described further lateral connections are provided, the same being so arranged as to secure the indeformability of the top portion of the gas envelope, notwithstanding its varying gas pressure.

Rigidly Suspended Closely Adherent Airship Car

The airship car is a rigid framework of similar construction to that of the rigid girder. The car is suspended from the girder knots by rigid tubular connections, thus forming with the girder a single rigid system. This arrangement enables a ready setting up and eventually the fitting of the rigid connecting shaft (or pit) it further greatly contributes to the compactness of the whole, a feature which is of great utility as well in sailing as in respect to maneuvering from the ground.

The car is arranged close to the outer envelope and nearly in touch with it; almost the whole of the car is closed in with glass or with spread canvas according to the position concerned.

All these arrangements efficiently assist in lowering the resistance to flight.

Stiffening of Front Portion of the Envelope

The object of this stiffening is to permit of an appreciable reduction in the pressure of the outer envelope relatively to the external aerodynamic pressure. The stiffening frame also serves to receive the air-intake valves, the object of which is to keep up the internal pressure while traveling.

The stiffening frame consists of a rigid calotte, from which a set of slightly elastic bars extend to support the front portion of the outer envelope and take up the reaction of the external air. This sort of umbrella is rigidly supported by the girder so that even wind gusts cannot deform the front of the envelope or press it inwardly.

The air intake valves admitting air into the air chamber consists of a large number of balanced blades, arranged in the center of the rigid calotte; the working of these blades is free from shaking and rattling.

Beside the air inlet just described there is an automatic air-relief arrangement, the object of which is to prevent excessive pressures in the air chamber. This object is achieved by means of automatic valves arranged at the rear of the airship in a zone where the areodynamic influence of velocity is practically nil.

The complex of these arrangements and the dimensions adopted for the air and gas valves enable high speeds in the ascent and descent—up to 1000 meters in five minutes—without need of the pilot ever minding the gas or air chambers and yet without appreciable pressure variations taking place in these chambers.

A fan, which is kept running only during the maneuvers from the ground, serves to maintain the outer envelope under pressure and prevent its deformation, when this cannot be performed by the front air-intake valves.

Flexible Gratelike Steering Surfaces

The steering surfaces of the "F" dirigible are generally arranged in two sets: one for the dynamic compensation of the natural variations in the static equilibrium, this set being built up of horizontal surfaces forming two symmetrical grates carried from the car not far from the airship's center of gravity, and the other for steering the ship horizontally and vertically, this set being built up of vertical and horizontal surfaces forming two symmetrical grates which are carried from the girder and arranged at the stern.

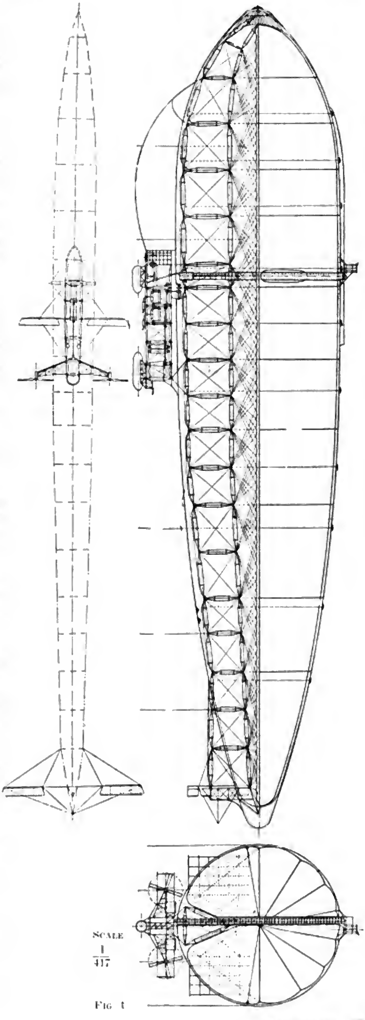


FIG. 1

The former set represents a maneuvering convenience rather than an actual necessity and can accordingly be dispensed with, a small advantage being thus realized in weight and speed.

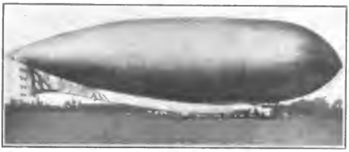


Fig. 3 Dirigible F2, City of Milan

The characteristic feature of these surfaces is that they are not stiff and do not swing round an axis, as is the case with all other rudder types, but are flexible and have their front edge rigidly secured in the respective grates, the controlling means being attached to their rear edge.

When operated by the pilot and bent, these surfaces are cambered like airplane wings, the efficiency being very high with small bendings and still good with greater bendings.

The controlling of these surfaces is always effected through the intermediary of an irreversible worm gear.

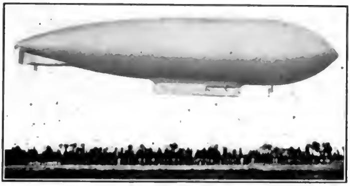


Fig. 4 A Side View of the F3

These surfaces built up grates of simple and compact construction giving rise to but a small amount of passive head resistances.

The described arrangement of the steering gear concurs in keeping low the total head resistance even when, the air being violently agitated, the operation of the rudders is hardened.

Propelling Apparatus

The best arrangement thus far designed appears to be that of dirigible F.5 now in process of construction. This dirigible is fitted with two engines arranged on the center line of the car, each of them driving a propeller through a friction clutch and a set of wheel gears, the two sets being connected together by a gear box so as to cause, the motion of the two propellers to be perfectly alike, and to enable both propellers to be driven by a single engine, or either propeller to be driven from the engine which is ordinarily intended for the other propeller.

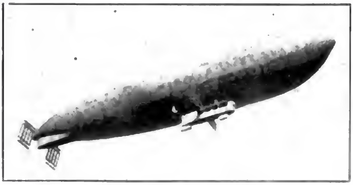


Fig. 5 A Later Type, the F4

Close to each engine is arranged the corresponding radiator, fitted with adjusting screen and directly coupled fan supplying the necessary air stream also for a ventilated hood surrounding the engine, to prevent accumulation of gases. Each engine is also fitted with oil cooler, exhaust cooler and silencer.

When either of the engines is accidently stopped, it can still be kept hot by means of pipes leading from the running engine. This arrangement facilitates restarting, saves the time which should otherwise be spent for running the engine up to full power, and obviates the danger of the water and oil freezing at the low temperatures obtaining at the higher elevations.

In the "F" dirigibles the auxiliary apparatus such as air chamber fan, lighting dynamo, compressed air pump and intermittent switch for the route lanterns, are driven from a special shaft, the motion of which is secured by either engine without need of any interference by the pilot.

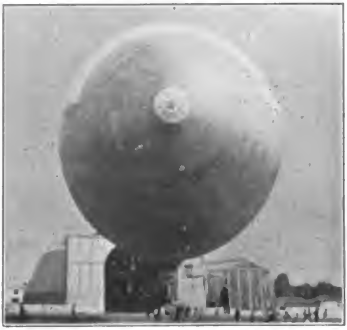


Fig. 6 The Air Inlet Arrangement Can Be Seen

The compressed air supplied by the small pump just mentioned serves for the pneumatic control of the valves, for conveyance of the gasoline and for inflation of the landing floating devices. The gasoline supply is so arranged as to be easy, of certain action and reading controllable at any moment.

Screw Propellers with Adjustable Reversible Pitch

The first "F" dirigibles had fixed blade propellers with large diameter and large pitch to suit. These propellers showed a very high efficiency but required a reversing gear for the maneuvers near the ground; they also required shafts revolving at low speeds and very heavy. In order to comply with the practical maneuvering requirements and reduce the air ship's weight, metal propellers with adjustable reversible

Fig. 7 A Later Type, the F4

pitch have been adopted in the latest types, like the propellers of the Army dirigibles M, F and V.

In the dirigibles F.5 the pitch of either propeller is adjusted separately, owing to which the propellers can be used in addition to or in substitution for the vertical rudders for maneuvering near the ground.

Upper Platform with Shaft and Ladder Communication with the Car

The invariability of the dimensions of the "F" dirigibles enables a most convenient arrangement of the upper platform and the vertical shaft and ladder connecting the platform with the car. The ready accessibility of the upper platform is considered by all experienced men a *sine qua non* of an airship's military efficiency.

The upper platform is carried on rigid ribs fixed to the two top meridian lines of the gas envelope which are held fast by longitudinal partitions. The ribs extend sufficiently to make the platform (even when the actual volume of the gas compartment reaches its lowest limit as steady as if it rested on a rigid framework.

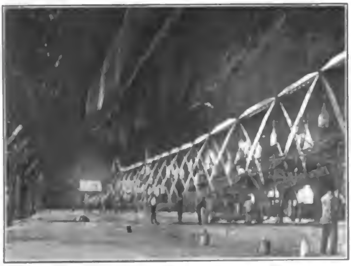


Fig. 8 Inflating a Dirigible—The Girder Work is Clearly Seen

This circumstance facilitates the installation of the vertical shaft (or pit) with a ladder inside.

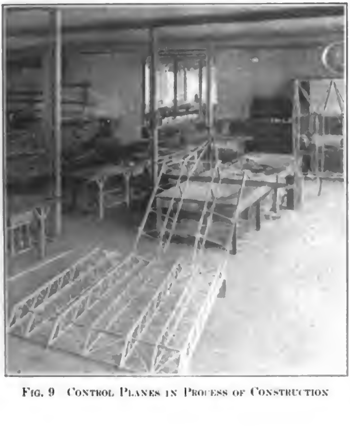


Fig. 9 Control Planes in Process of Construction

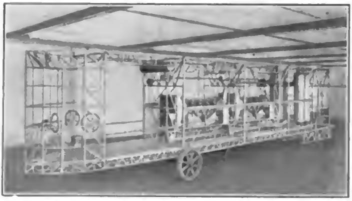


Fig. 10 The Car, Ready for Transportation Into the Hangar

General Remarks

The figures in the annexed table clearly show the progress that has been made by the Societa' Leonardo Da Vinci in their successive constructions and bear out the high qualities of their more recent airships, viz.: the F.4, whose characteristic advantages have been demonstrated by actual practice, and of F.5 which is now in process of construction.

The following points are noteworthy:

(1) Even with average volumes and consequently moderate sizes it is possible to attain such relative lightness as will ensure that the highest altitudes will be reached.

(2) High speeds can be attained, at least at the high altitudes that are usual for military purposes.

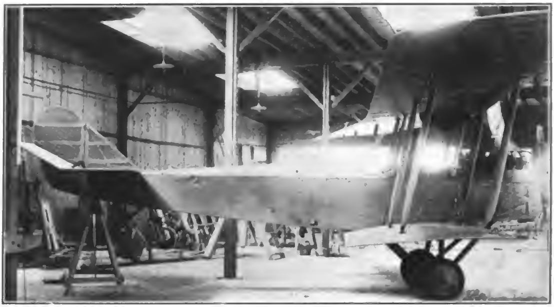
(3) The total head resistance is very low.

(4) The compact construction of these dirigibles allows steep inclinations of their axis to the horizontal, and rapid ascending and descending speeds. Thus assuming that, in addition to the fuel and lubricating oil, 10 per cent of the fuel weight should be allowed for such supplies as water, victuals, etc., and assuming another 700 kilos weight for the crew and reserve ballast, the F.5 dirigible would be capable of starting from its base without making use of its dynamic ascending power, could rise at once up to 3500 m. and reach a desired object 800 km. away at the rate of 68 km. an hour, stand over its target at an altitude of 4000 m., throw 1600 kilos weight of bombs and return to its base, always keeping at altitudes over 5000 m. Attention is called to the fact that to travel at the average speed of 68 km. per hour at an altitude of 4000 m. the airship requires only 185 h.p. out of the 480 h.p. which can be developed from its two engines.

(5) Velocities of 110 km. an hour could be realized at high altitudes by increasing the volume to about 30,000 cubic meters, that is to say with a "F.7" type, the characteristic of which would be such as stated in the last column in the appended table.

	F. 1	F. 2	F. 3	F. 4	F. 5	F. 6	F. 7
Equator diameter........m.	14	18	18	18	20	20	23
Length between perpendiculars.................. m.	40	72	90	90	90	90	110
Total capacity.......cb.m.	3,700	13,000	15.000	15,000	19,000	19,000	30.000
Gas chamber capacity.cb.m.	3,267	11,800	13.800	13.900	17,800	17,800	28,000
Number of tight compartments..................	1	12	12	12	12	12	12
Total weight per cubic meter of gas..................Kg.	0.257	0 712	0 762	0.668	0.544	0 578	0.541
Total weight (exclusive of crew, armament and provision)..............Kg.	2.800	8,100	10,500	9,300	9.700	10,300	15.200
Total weight that can be carried at 4,000 m. altitude ....Kg	—	—	—	1.400	3,500	2,900	5.500
Maximum height attainable (with the help of aerodynamic power and with an ordinary crew and provisions for raid of 300 km) ....m			3,100	4,500	6.500	6,000	6.500
Average ballast-discharge per meter for rising about 4,000 m. high..............Kg				0 950	1 220	1.220	1 920
Engines..................	1	2	4	2	2	4	4
Total power of engines (as measured on the ground) ....H.P	40	170	400	320	480	760	1400
Maximum power which the engines are actually called upon to develop when travelling..........H.P.	30	160	360	300	300	425	800
Maximum speed near the ground.......Km. per hour	50	65	74 5	73	70	75	80
Maximum speed at 2,000 m. ....Km. per hour	—	62.5	74	80	75	81	90
Maximum speed at 4,000 m ....Km. per hour				78	80	90	97
Maximum speed at 5,000 m ....Km. per hour			—	78	79	95	104
Maximum speed at 6,000 m. ....Km. per hour					78	100	110
Fuel and lubricating oil consumption at cruising speed (0.85 maximum) and at the indicated altitudes, per hr			Kg. 45 m. 2.500	35 4,000	45 4,000	65 4.000	125 4,000
Ditto.................per km	0 108	0 357	0 660	0.377	0.665	0 85	1 47
Rising and descending speed 1,000 m. in			6'	5' 3''	6'	6'	6'

The Standard Model "J-R"



SIDE VIEW OF THE STANDARD J-R PURSUIT MACHINE, SHOWING NEW EXHAUST MANIFOLD. NOTE THE PRONOUNCED STAGGER

The Standard Aero Corporation has recently produced an interesting development of their primary training model "J."

The 90hp. Hall-Scott has been replaced by the A-7a six-cylinder engine of the same company. Very high compression enables this engine to deliver 175 horsepower.

Instead of the R.A.F. 3, the U.S.A. 6 is now employed. The use of a better wing section and the higher power have transformed a slow school machine into a very fast reconnaissance type.

Three views of the machine are shown herewith, together with three interesting photographs.

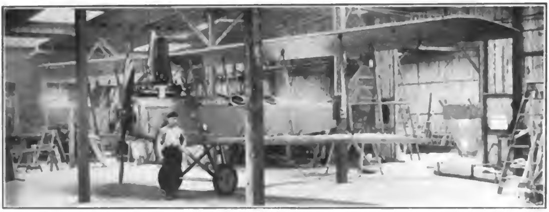
The new stream line exhaust header carries the exhaust well over the upper surfaces. The landing gear is streamlined throughout. The axle rises in vertical guides, and when normal rests in a U-shaped steel case streamlined with aluminum.

All wing struts are provided with ball and socket fittings.

The engine bed is made very rigid by means of steel tube stays which connect the ash engine supports to the longerons.

There is a single control of the Dep. type in the rear cockpit.

The general specifications given by the Standard are as follows:



THREE-QUARTERS FRONT VIEW OF THE STANDARD J-R, SHOWING NEW EXHAUST LEADER, WHICH CARRIES EXHAUST OVER THE TOP WING

Dimensions, Specifications and Performance of the Model J-R

General Dimensions

Wing span, upper plane	42' 10"
Wing span, lower plane	31'
Wing chord	6'
Gap between wings	71"
Stagger	10"
Overall length of machine	27' 2½"
Overall height of machine	10' 10"
Angle of incidence	2½°
Dihedral angle	3°
Sweepback	5°
Wing curve	U. S. A. No. 6
Horizontal stabilizer, angle of incidence	0°

Areas

Upper wing	258 sq. ft.
Lower wing	159 " "
Total supporting surface (wings and ailerons)	417 " "
Ailerons (each 21 sq. ft.)	42 " "
Stabiliser—horizontal	23.7 sq. ft.
Stabiliser—vertical	3.7 " "
Elevators (each 11 sq. ft.)	22 sq. ft.
Rudder	10 " "
Maximum load per sq. ft. supporting surface	5.75 lbs.
Maximum load per H.P.	13.7 "

Weight

Net weight—machine empty	1764 lbs.
Gross weight—machine loaded	2400 "

Performance

Maximum speed—full load	95 M. P. H.
Minimum speed—full load	48 "
Gliding angle	1 to 11
Climbing speed in 10 minutes	5000 feet

Power Plant

Hall-Scott A-7A special. 6 cyl. vert. four stroke cyle. water cooled

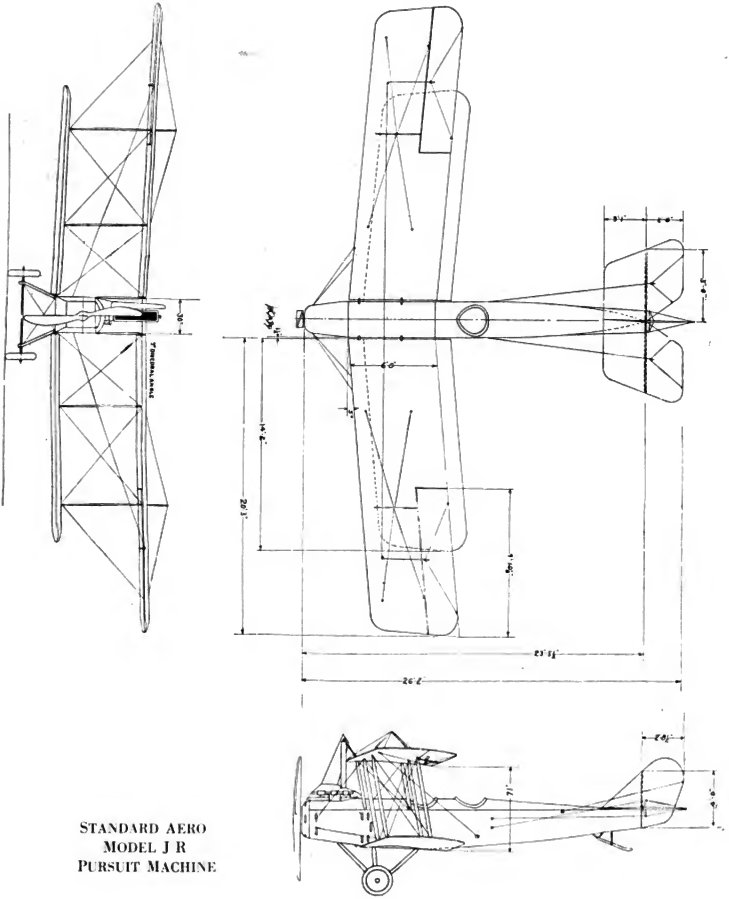
Horse-power (rated at 1400 R.P.M.)	175 H.P.
Weight	605 lbs.
Bore and stroke	5½" x 7"
Fuel consumption per hour	14 gals.
Fuel tank capacity	51 "
Gravity tank capacity	7¾ "
Total tank capacity	58¾ "
Oil capacity in crank case	4 "

Propeller

Make	"Standard"
Material	Black walnut
Diameter	8' 4"
Pitch	5' 6"
Direction of rotation (viewed from pilot's seat)	Clockwise

Landing Gear

Number of wheels	2
Size of wheels	26" x 4"



STANDARD AERO
MODEL J R
PURSUIT MACHINE

Extracts from Inspectors' Manual Aviation Section, Signal Corps, U. S. A.

(Continued from the issue of July 15.)

Inspection of Linen

All linen used in airplane construction should be up to the following specifications:

Free from all knots or kinks.
Without sizing or filling.
As near white as possible.
Weight, between 3.5 and 4.5 ounces per square yard.
Strength per inch should comply with Signal Corps specifications.

Inspection of Propellers

Army inspectors should inspect all wood to be used in propellers for Government use. This wood should be well seasoned; free from knots, sap pockets, dry rot, and should be straight in grain.

Laminations should extend the entire length of the propeller of the two-bladed type and no splices should be allowed in laminations in the hub. On three-bladed type the splices should be made so as to get greatest glue surface and greatest cross section of wood.

Metal tipping should be inspected to see that the metal lies close to wood, that nails or rivets have not split the blade, and that solder is placed smoothly and properly.

Propeller hubs should be pressed into propellers on an arbor press, and great care should be taken that the wood is not injured in the process but that a tight fit is secured. Hub bolts should fit hub flanges with very small clearance but without filling, and should be a light drive fit through wood. The taper and keyway or splines should be carefuly inspected and no nickel plating should be allowed in these surfaces. Hub bolts should be wired in an approved manner.

Before shipping from factory, all propellers should be checked for balance (standing) on true knife edges, for checks in wood, for cracks in glue joints, and for alinement of blades. This final inspection should be made immediately before shipping.

Propellers should be checked for pitch as per sketches or in some other approved manner.

The maximum allowable variation in checking blades of the same propellers is as follows:

	Maximum variation, in inches.
For 8 feet diameter	0.24
For 8 feet 6 inches diameter	.25
For 9 feet diameter	.27
For 9 feet 3 inches diameter	.28
For 9 feet 6 inches diameter	.29
Alinement (to be measured at a point about 2 inches from tip):	
For 8 feet diameter	.125
For 8 feet 6 inches diameter	.166
For 9 feet diameter	.200
For 9 feet 3 inches diameter	.225
For 9 feet 6 inches diameter	.250
Pitch (taken at points 62½ per cent, 75 per cent, and 87½ per cent from hub):	
For 5 feet 5 inches pitch	1.00
For 5 feet 6 inches pitch	1.02
For 5 feet 11 inches pitch	1.10

Inspection of Radiators

Radiators should receive the following test:

Each radiator is to be submerged in water and tested with an air pressure of 6 pounds, and when passed must be free from all leaks. In inspecting radiators, care should be taken that provision is made to install in such a way that the radiators will not be injured by vibration.

Inspection of Wood

All wood should be inspected before varnish is applied. The following questions should receive the inspector's approval before he passes any wood for Government use:

Is grain satisfactory?
Are there any sap or worm holes?
Are there any knots that look as if they would weaken member?
Any brashiness?
Any holes drilled for bolts or screws that would weaken member?
Any splits or checks?
Are laminations glued properly?
Are there any plugged holes?
Any signs of dry-rot?

Inspection of Metal Fittings

When fittings are copper plated and japanned, the inspection should take place after the copper plating. The following questions should be approved by the inspector before being passed:

Have fittings been bent in assembly?
Does filing show any defects that lessen its strength?
Are holes drilled properly?
Do fittings fit?

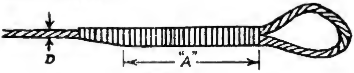
Inspection of Sheet Aluminum

Sheet aluminum should be inspected for defects such as cracks, bad dents, and under specifications in gauge. Where openings occur in sheet aluminum the corners should be rounded, allowing a good-sized radius.

Correct Winding for Different Sized Cables

Windings must be even, with a nice stream-line effect at end of winding. When solder is used, care should be taken that acid does not go beyond soldered portion of cable.

Dimensions "A" to be at least 15 times D or diameter of cable. (See sketch.)



Size of cable. *Inch.*	Length of winding. *Inches.*	Breaking strength. *Pounds.*
1-32	1½	185
1-16	1½	500
3-32	1½	1,100
7-64	1¾	1,600
⅛	2	2,100
5-32	2⅜	3,200
3-16	3	*5,500
7-32	3⅜	6,100
¼	3⅞	8,000
5-16	4¾	12,500

---

* 5,500 pounds for cable, but only 5,100 pounds for loop.

Only nonacid flux should be used in soldering.

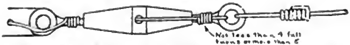
Approved Method of Wiring Turnbuckle

Inspectors will examine all turnbuckles in every assembled machine to ascertain that these parts are locked in a manner complying with the best practice. When wire is used to lock the turnbuckle, it should be of 20 ga. hard copper wire and secured in an approved manner. Wiring in the manner shown below has proved most satisfactory.

Notes on Turnbuckles and Connections

Standard test for turnbuckles: rods are screwed into barrel full length of threads on rods, so that last thread is flush with end of barrel, unless otherwise stated.

Turnbuckles held by pin connections.

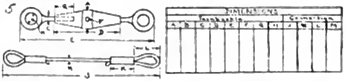


Piston speed: 0.1 inch per minute.

Elongation is measured as per cent of length of rod, when break occurs in rod, and per cent of total length of barrel when break occurs in barrel.

Standard Dimensions and Letters for Turnbuckles

Inspectors submitting wire or cable test specimens to this office for test by the Bureau of Standards should follow this procedure:



The specimen should be 30 inches long, with the standard connections used in service by the manufacturer attached to both ends.

Testing of Ignition Systems

Before Mounting on Engine

It is advisable to test the ignition system before it is mounted on the engine, as this may save considerable work later in tracing troubles.

I. Magnetos

1. Mount magneto on a stand. This should consist of a metal plate with means of fastening the magneto; the test stand must consist of nonmagnetic metal, such as aluminum or brass, and be connected to a grounded water or gas pipe in order to avoid static discharges.

2. Provide magneto with a pulley for driving; pulley with two or three steps of different radii, and with a belt groove on each step for driving at different speeds, is preferable.

3. Provide necessary amount of test spark gaps, one for each high tension terminal on the magneto, see sketch. Clean test spark gaps with alcohol in order to remove all moisture and prevent surface leakage of high tension current. Adjust test spark gaps as per sketch, distance from (2) to (3) should be so as to allow a thin piece of paper to be slipped in between the points, without the paper being torn, but the paper should touch both points at the same time. Distance between (1) and (2) should be 5 mm.; connect (2) to high-tension terminal on magneto and (1) to the grounded test stand.

4. Use standard high-tension cables for making connections; all contacts must be good and all connections tight.

Adjustments of Magneto

5. If possible, remove cap on breaker box, so that operation of breaker points can be observed during test. Adjust the distance between the breaker points before the test; the distance should be as follows:

Dixie magnetos, 0.45-0.55 mm., or 0.018-0.022 inch.
Berling magnetos, 0.40-0.50 mm., or 0.016-0.020 inch.
Bosch magnetos, 0.35-0.45 mm., or 0.014-0.018 inch.
Berkshire magnetos.
K. W. magnetos.

Breaker points must be clean, make contact over the whole surface, and line up properly; no pitting, burning, or oxidizing must have taken place.

Test

6. Allow magneto to run for 10 minutes in order to be run in before starting the test; the speed of the magneto during the test should be 15 per cent over the rated magneto speed. Rated magneto speed means the speed at which the magneto is running when the engine is running at its full rated speed. The magneto should be tested for three hours at above speed.

If it is found necessary to change magnetos after the engine has made the six hours' run, the new magneto should be given a six hours' run on the test bench at 15 per cent over rated speed. After this, the magneto is mounted on the engine. The engine should then be tested for one hour on dynamometer to check up the power at full rated speed.

7. Observe closely the sparks; all sparks should be of the same size—i.e., the corona or the flame on the sparks should be of the same size and be even, not show periodical increasing or decreasing. It is necessary to watch a spark closely for two to three minutes in order to detect any missing. No missing must appear at above speed.

8. Watch closely the performance of the breaker points. No arcing between the points must take place. Listen for excessive noise from the ball bearings; excessive noise indicates that the bearings are not properly adjusted, and this may cause breakdown in short time.

9. For the slow speed, run the magneto at approximately 50 r.p.m., and increase the speed slowly until the sparks appear absolutely regular without missing. This should be done with the magneto in full advance, as well as in full retard position. Note these speeds: It should not exceed 100 to 150 r.p.m. for full advance, and 200 to 275 for full retard position, as the starting of the engine otherwise will be too difficult. The variation of the magneto speed can be made by using a friction disk arrangement, or if an electrometer is used by changing the resistance in the field and in the armature.

Inspection of Magneto After Test

10. After the test is finished the magneto should be inspected and the following points noted:

The breaker points must still be in good condition; no burning must have taken place.

Remove the distributor plate and see if carbons show any excessive wear. The wearing surface should show a high polish, and no carbon dust should be seen inside the distributor plate.

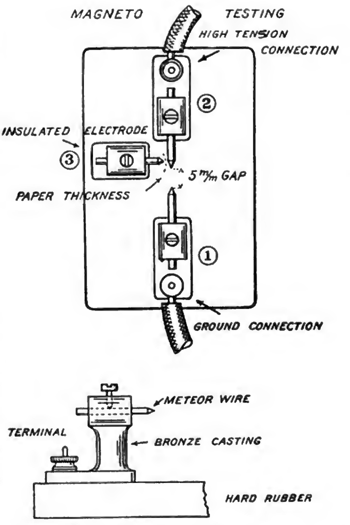
The segments inside the distributor plate must not show any burning of the edges, and the entire surface should show a good polish. Segments must not extend beyond the surface of the insulation composition.

Reassemble the magneto, and it is then ready to be mounted on the engine.

II. Battery System

11. Mount the timer distributor similar to the magneto. This requires special fixtures, which do not necessarily have to be of non-magnetic material. Provide a pulley for driving the timer distributor in a similar way as for magneto under No. 2.

ARRANGEMENT OF TEST GAP FOR MAGNETO TESTING



AERONAUTICAL DIV. SIGNAL CORPS
U.S. ARMY

12. Make proper connections between the timer distributor, high-tension coil, and storage battery, as indicated on manufacturer's diagram, and make high-tension connection to test spark gaps as for magneto under No. 3. Do not make final connection between the high-tension coil and the storage battery until immediately after the timer distributor is started to run, as the excessive current which passes through the coil when the timer is standing still will injure the coil if it is allowed to flow for any longer period. Connect an amperemeter with scale reading 0-25 amperes in between the storage battery and the coil, and report the current consumption when the timer distributor is running at rated speed.

13. Use a storage battery of not less than 50 ampere-hours, and ascertain before test that the battery is 75 per cent charged—i. e., reading with hydrometer should show not less than 1,200 "points"; connection to storage battery must be clean.

14. Make all adjustments as described for magneto under

No. 3, No. 4, and No. 5, and make test as described for magneto under No. 6, No. 7, and No. 8.

15. Inspect the timer distributor as under No. 9.

After Mounting on Engine

I. Magnetos

16. Check the point of firing. This depends on the type of engine, compression, and ignition system used; battery ignition calls for a larger degree of advance than does magnetic ignition; the proper point of setting is decided by the manufacturer of the engine. The point of firing can be measured on the piston stroke in inches, but it is preferable to measure it in degrees on a graduated dial, if such can be placed on the crank shaft or on the propeller hub.

17. If two independent ignition systems are used, the difference in firing point between these should not exceed 2 to 3 degrees. This should be checked up in the same way as above.

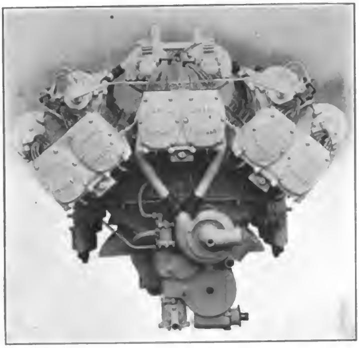
Wiring Cables

18. See that all terminals are in good condition, give good contact, and that all terminals are tight and secured. Check up all wiring. High-tension cables must be held in tubing of insulation material or strung free in the air, held at intervals by supports of fiber or bakelite, but should not be inclosed in metal tubing. High-tension cables should not come in contact with any grounded metal, as this in time may cause breakdown. High-tension cables should be held in such a way that no movement of the cables can take place, as this may result in chafing of the cable insulation.

(To be continued)

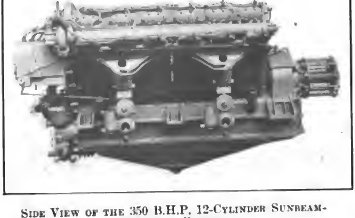
The New Sunbeam Overhead Valve Type Engines

The censorship has now passed for publication a few views of some of the latest Sunbeam-Coatalen aircraft engine types. These are interesting alike for the points they possess, which may be of service to aircraft engine production in the future, and for the features in which they must always differ from that which is suitable for car practice.

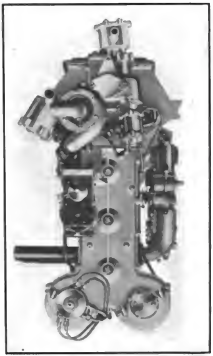


Magneto End View of the 475 B.H.P. 18-Cylinder Sunbeam-Coatalen Engine of the Broad Arrow Type

In regard to all the types of engines illustrated, it will be observed that the crankcase and nose piece are cast in one, whereby there is achieved the dual gain of lightness and proportionately greater rigidity, to say nothing of accessibility and so forth. In these features such engines must always differ from motor car practice. Another point concerns the absence of flywheels. The engine base, on the other hand, which is a dry sump in combination with a compound pump at the bottom, represents a scheme which may become a feature of standardized motor car engine practice at some future period. Every example of this series of Sunbeam-Coatalen aircraft engines has overhead valves on the principle of two inlet and two exhaust valves per cylinder, with the sparking plug set in practically the ideal position. The series of views illustrates the vertical, narrow type of engine; the V-form; and the broad arrow type wherein three rows, each of six cylinders, are set on a common crankcase. In this water-cooled series the gasoline and oil consumption is notably low, as is the weight per horsepower, particularly in face of the handicap under which British manufacturers have to work nowadays owing to the relative unreliability of magnetos.



Side View of the 350 B.H.P. 12-Cylinder Sunbeam-Coatalen Engine



Magneto End View of the 170 B.H.P. 6-Cylinder Sunbeam Coatalen Engine

Thus in regard to the 18-cylinder overhead valve Sunbeam-Coatalen aircraft engine of 475 brake-horsepower, there are no fewer than half a dozen magnetos. Each magneto is enclosed. Two sparks are furnished to each cylinder from independent magnetos. On this engine there are also no fewer than six carbureters. Shortness of crankshaft, therefore of engine length, and absence of vibration are achieved by the linking of the connecting rods. Those concerned with three cylinders in the broad arrow formation work on one crankpin, the outer rods being linked to the central, master one. In consequence of this arrangement, the piston travel in the case of the central row of cylinders is 160 mm., while the stroke of the pistons of the cylinders set on either side is in each case 168 mm.

The duplicate ignition scheme also applies to the 12-cylinder, 350 brake-horsepower Sunbeam-Coatalen overhead valve aircraft engine type. It is distinguishable, incidentally, by the passage formed through the center of each induction pipe for the sparking plug in the center cylinder of each block of three. In this, as in the 18-cylinder and the 6-cylinder types, there are two camshafts for each set of cylinders. These camshafts are lubricated by low pressure and are operated through a train of enclosed spur wheels situated at the magneto end.

Course in Aerodynamics and Airplane Design

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and

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PART II—SECTION 12

Wing Structure Analysis for Biplanes

Reactions in Plane of Lift Truss Due to Upper Rear Spar at 0 Deg.

At the conclusion of the previous section, we drew the bending moment diagram for the upper rear spar as a continuous beam, and found the appropriate reactions. But since the bending moment diagram was drawn for that component of the force in the plane of the lift truss which was in the plane of the spar web, allowance has to be made for it on reverting to the lift truss. The running loads were in the ratio of 14 to 13.8. Hence reactions are

$$R_3 \quad 83.1 \times \frac{14}{13.8} = 84.8 \text{ lb.}$$

$$R_5 \; 116.5 \times \frac{14}{13.8} = 118.0 \text{ lb.}$$

$$R_1 \quad 34.6 \times \frac{14}{13.8} = 35.1 \text{ lb.}$$

Reactions in Plane of Lift Truss Due to Lower Rear Spar at 0 Deg.

Since the spacing of the supporting points on the lower wing is identical with that of the upper wing, and the slight overhang is the same, the bending moment diagram and the shears and reactions will be in direct ratio to the loads. The ratio of loads on upper plane to lower plane is 14 to 11.5. Hence reactions are

$$R_3 \quad 84.8 \times \frac{11.5}{14.0} = 70 \text{ lb.}$$

$$R_5 \; 118 \quad \times \frac{11.5}{14.0} = 88 \text{ lb.}$$

$$R_1 \quad 35.1 \times \frac{11.5}{14.0} = 28.8 \text{ lb.}$$

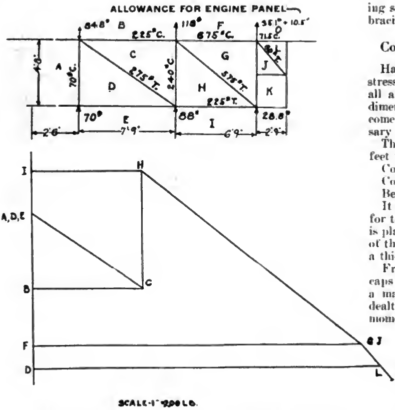


FIG. 1 STRESS DIAGRAM OF REAR LIFT TRUSS AT 0 DEG. INCIDENCE

Stress Diagram for Rear Lift Truss at 0 Deg.

We are now in a position to draw the stress diagram for the lift truss as shown in Fig. 1. The only other load to be added is 10.5 lb., which is allowance for half the air force due to the engine panel acting on the rear spar.

In drawing this stress diagram, the strut G J is assumed as taking no tensile load, and the lift load at O F is transmitted by the cross wire L J to the body.

Stress Diagram for Internal Upper Wing Bracing at 0 Deg.

In Fig. 2 is drawn the stress diagram for the internal bracing of the upper wing at 0 deg. incidence.

The spars have so much less resisting moment in the plane of the wing that it is perfectly justifiable to treat the interplane wing bracing as a pin-jointed structure and neglect all consideration of bending moments.

The running loads per foot run are taken from the preceding sections, with the addition of ½ lb. drift at each external bracing point.

Computations for Dimensions of Rear Upper Spar

Having drawn the bending moment diagram, the lift truss stress diagram and the internal wing bracing stress diagram, all at 0 deg. incidence, we are in position to determine the dimensions of the rear upper spar. Since the worst loads come on the rear spar at this angle of incidence, it is not necessary to recompute it at 16 deg. also.

The worst loads it has to meet occur in the inner span, 3 feet from the wing hinge:

Compression from the lift diagram of 675 lb.

Compression from the drag diagram of 330 lb.

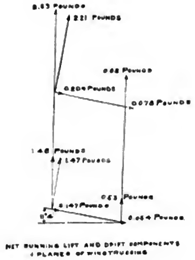
Bending moment of 44 ft. lb.

It is first of all necessary to fix the effective depth of spar for the wing section employed, namely, the R.A.F.6. The spar is placed at 30 per cent from the rear edge, where the thickness of the wing is .054 of the chord. For a 62-in. chord, this gives a thickness of 3.34 in., or 3 21/64 in. very nearly.

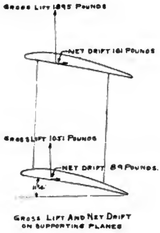
From this must be deducted the thickness of the two rib caps or flanges. The construction and dimensioning of ribs is a matter of some uncertainty and controversy, and will be dealt with fully in a later article. We will assume for the moment that a thickness of ⅛ in. will be sufficient for the rib flanges, so that the effective depth of the flanges will be reduced to 3 5/64 in. The actual drawing up of the beams is largely a matter of trial and error. That is to say, an apparently suitable section has to be drawn in its area, and moments of inertia, etc., have to be computed together with the factor of safety consequent thereon.

After a number of trials, the spar section of Fig. 3 is found to be satisfactory.

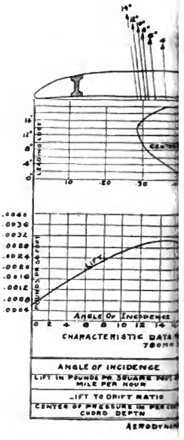
ANALYSIS FOR LOW SPEEDS, 50 M.P.H.



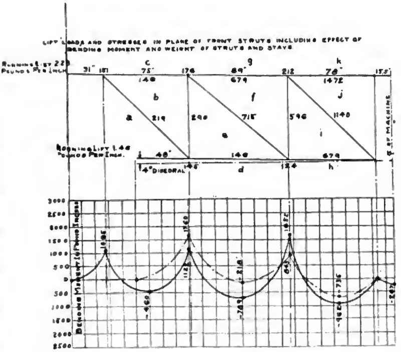
NET RUNNING LIFT AND DRIFT COMPONENTS IN PLANES OF WING TRUSSING



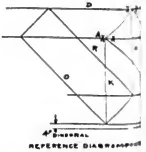
GROSS LIFT AND NET DRIFT ON SUPPORTING PLANES



LIFT LOADS AND STRESSES IN PLANE OF FRONT STRUTS INCLUDING EFFECT OF BENDING MOMENT AND WEIGHT OF STRUTS AND STAYS

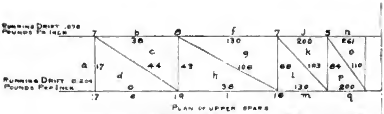


BENDING MOMENTS IN FRONT, TOP AND LOWER SPARS IN PLANE OF I BEAM WEB



SYMBOL	MEMBER	MATERIAL	SECTIONAL AREA SQUARE INCHES	MOMENT OF INERTIA	SECTION MODULUS
A	FRONT SPAR	SPRUCE	4.0	8.1	3.8
B	"	"	"	"	"
C	"	"	"	"	"
D	REAR SPAR	"	4.73	5.48	3.54
E	"	"	"	"	"
F	"	"	"	"	"
G	FRONT SPAR	"	4.0	8.1	3.8
H	"	"	"	"	"
I	REAR SPAR	"	4.73	5.48	3.54
J	"	"	"	"	"
K	LIFT STRUT		4.88	0.79	
L	"		7.88	2.07	
M	"		4.16	0.57	
N	"		6.5	1.39	
	LIFT CABLE	SOFT DRAWING STEEL	NO OF CABLES	DIA OF CABLES	BREAKING LOAD
O	"	"	2	5/32	6400
P	"	"	2	"	"
Q	"	"	2	7/32	11200
R	"	"	2	5/32	6400
S	"	"	2	"	"
T	"	"	2	7/32	11200

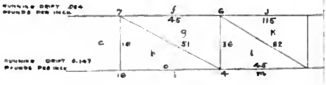
FACTORS OF SAFETY ARE GIVEN
FOR STRESS IN DRIFT WIRES AND



RUNNING DRIFT .078 POUNDS PR INCH
RUNNING DRIFT 0.209 POUNDS PER INCH
7
b
8
f
7
j
5
n
36
130
200
261
c
g
k
o
a
17
44
43
106
68
103
64
110
d
h
l
p
o
38
130
200
:7
e
19
i
16
m
q

PLAN OF UPPER SPARS

DRIFT LOADS AND STRESSES IN THE PLANES OF THE UPPER AND LOWER SPARS INCLUDING EFFECT OF STRUT AND WIRE RESISTANCE AND EXCLUDING TENSION OF EXTERNAL DRIFT. STRESS IN EXTERNAL WIRES ASSUMED BEARING ENTIRE LOAD



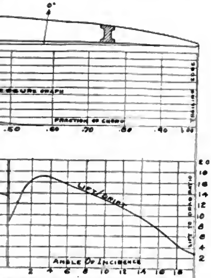
RUNNING DRIFT .054 POUNDS PER INCH
RUNNING DRIFT 0.147 POUNDS PER INCH
7
f
6
j
45
115
g
k
c
18
51
36
82
h
l
o
18
i
4
45
m

PLAN OF LOWER SPARS

ASSEMBLED DATA AND

FIG. 4

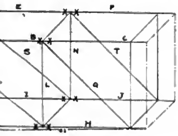
LTANT WING FORCE AT VARIOUS ANGLES
CIDENCE AND SAME SPEED



ONOPLANE WING SHAPE - AIR AT 15° CENT.
ECT RATIO 6/1

0°	2°	4°	6°	8°	10°	12°	14°	16°	18°
[illegible]	.0011	.0015	.0018	.0022	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.5	16.3	17.1	15.8	14.2	12.6	11.6	9.7	7.5	4.3
.575	.425	.358	.329	.312	.302	.292	.280	.296	.330

ATA AND DIAGRAMS

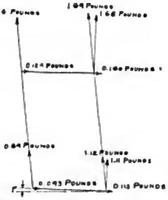


GREATEST STRESS MARKED THUS X

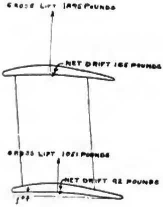
LOW SPEED			FOR HIGH SPEED			
S IN LBS/SQ.IN.		FACTOR OF SAFETY	FIBRE STRESS IN LBS/SQ.IN.			FACTOR OF SAFETY
LIFT	DRIFT		BENDING	LIFT	DRIFT	
37	0	20	±181	-22	0	33
170	+9	11	±266	-104	+13	19
369	+50	9	±266	-226	+70	16
12	-8	49	±241	-24	-10	24
53	-28	26	±358	-109	-38	13
115	-55	19	±356	-236	-80	10
37	+0	13	±273	+22	+0	23
170	+11	16	±149	+104	+15	25
12	-9	30	±365	+24	-13	18
53	-24	58	±182	+109	-36	26
296		8		-181		14
596		11		-364		18
109		17		-224		8
221		20		-452		10
219		29		+134		47
715		9		+436		14
140		9		+696		16
+81		79		+166		38
+265		24		+542		11
+421		26		+865		13

R POINTS OF GREATEST STRESS
TRUTS SEE DRIFT DIAGRAMS.

COMPUTED VALUES

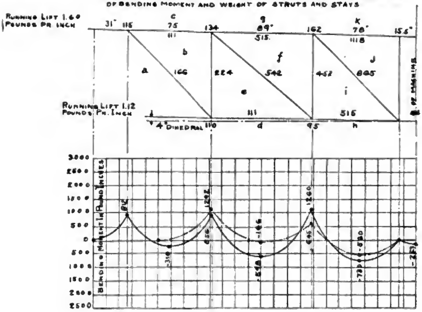


NET RUNNING LIFT AND DRIFT COMPONENTS
IN PLANES OF WING TRUSSING

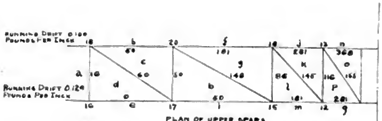


GROSS LIFT AND DRIFT
ON SUPPORTING PLANES

LIFT LOADS AND STRESSES IN PLANE OF REAR STRUTS INCLUDING EFFECT
OF BENDING MOMENT AND WEIGHT OF STRUTS AND STAYS

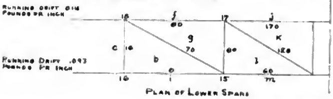


BENDING MOMENTS ON FRONT, TOP AND LOWER SPARS
IN PLANES OF I BEAM WEB



PLAN OF UPPER SPARS

DRIFT LOADS AND STRESSES IN THE PLAN OF THE UPPER AND LOWER SPARS INCLUDING EFFECT OF STRUT AND WIRE RESISTANCE AND EXCLUDING TENSION OF EXTERNAL DRIFT STRESS IN EXTERNAL WIRES ASSUMED BEARING ENTIRE LOAD



PLAN OF LOWER SPARS

The upper surface of the spar follows the outline of the R.A.F.6 wing section at this point, but in making computations the slight slope may be neglected.

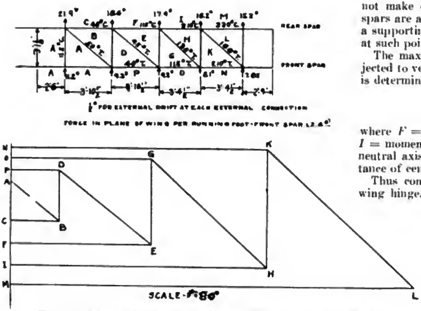

FORCE IN PLANE OF WING PER RUNNING FOOT - REAR SPAR = 4.8"
21.9"
18.6"
17.4"
16.2"
15.2"
REAR SPAR
FRONT SPAR
A
B
C
D
E
F
G
H
I
K
L
M
N
O
P
2'6"
3' 10½"
3' 4½"
2' 9"
½" FOR EXTERNAL DRIFT AT EACH EXTERNAL CONNECTION
FORCE IN PLANE OF WING PER RUNNING FOOT - FRONT SPAR 12.4"
SCALE

Fig. 2 Stress Diagram of Upper Wing Internal Drag Bracing at 0 Deg. Incidence

To compute the moment of inertia, the quickest way is to compute for the solid section and deduct the moment of inertia of the material channeled out. The moment of inertia of a rectangle being given by the formula $\frac{bd^3}{2}$

$$I = \frac{1.25 \times 3.08^3}{12} - \frac{.600 \times 2.02^3}{12} = 3.06 - .45 = 2.61$$

$$A = (1.25)(3.08) - 600 \times 2.08 = 3.94 - 1.25 = 2.69$$

The stress in the outermost fibers will now be given by the formula

$f = \frac{P}{A} + \frac{My}{I}$ where P = direct load, y = distance of outer fibers from the neutral axis and f = stress. Since $P = 1105$ lb., $M = 44$ ft. lb. $= 528$ inch. lb. and maximum $f = \frac{1105}{2.61} + \frac{528 \times 1.54}{2.69} = 725$ lb.

Allowing a maximum fiber stress for spruce of 6500 lb., we get a factor of safety of 8.9, which is in excess of the 7.5 specified by the Army for the front spar.

Similar computations can be carried out for the upper front spar at 16 deg.—since the biggest load is carried at this angle.

It must be pointed out, however, that although the formula $f = \frac{P}{A} + \frac{My}{I}$ is largely used, and is, therefore, perfectly sound on a comparative basis, the factor of safety given by it is not exactly true. Tests on breaking beams by bending show great variations from the above formula, depending largely on sections employed, but special values for moduli of rupture by bending are not available.

For the lower wing, if the same chord is employed as in the upper wing, and the spars have the same dimensions, no computations need be made, since the loads on the lower wing will always be considerably less. Whether with the same chord the lower spars should be smaller than the upper ones is a matter to be determined largely from the manufacturing point of view.

A Complete Example of Wing Analysis Arrangement

In Fig. 4 is shown the complete analysis for the wing structure of a Curtiss biplane. The methods employed in getting out this analysis are substantially the same as indicated above, and the method of presentation is an excellent model.

Computations for Shear in Spars

Wood is so much weaker in shear than in either tension or compression, that it is somewhat surprising that designers do not make computation for shear in the spar web—although spars are always made solid for 2 in. or 3 in. on either side of a supporting point, to allow for the maximum shear occurring at such points.

The maximum longitudinal shear for a beam which is subjected to vertical shear occurs at the neutral axis, and its value is determined by the formula

$$q = \frac{F}{Ib} A_1 y$$

where F = vertical shear at the point due to external loads, I = moment of inertia of whole section, b = breadth of web at neutral axis, A_1 = area of section above neutral axis, y = distance of centroid of this area from the neutral axis.

Thus consider the same upper rear spar 2 feet from the wing hinge. The shear at this point, as given by the shear force diagram of Fig. 7 of the preceding section, is 20 lb. Considering the section of spar shown in Fig. 3:

$I = 2.59$

$A_1 = \text{———} = 1.27$

$b = .625$ in.

$y = .87$ in.

$$q = \frac{20}{2.59 \times .625} \times 1.27 = .87 = 13.6 \text{ lb.}$$

Allowing shearing value of spruce to be 400 lb./sq. inch, we have a factor of safety of 29.4, which is amply sufficient. But cases might occur where the shear near supports is very large, and resistance to shear being largely due to the web, it is always advisable to make such computations.

(Editorial Note.)—With the completion of this section, the Course terminates in its present form. Articles dealing with special points in air plane design in direct continuation of the Course will appear at frequent intervals. The Course is undergoing revision prior to publication in book form.

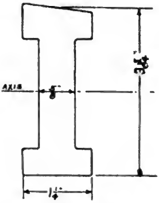


Fig. 3 Rear Upper Section

Aeronautical Patents

Copies of these patents may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

ISSUED JULY 3, 1917.

1,229,503. Filed August 28, 1916. To Knute W. Olson, St. Paul, Minn. Safety Device for Aviators.

1,229,297. Filed July 21, 1916. To Geo. Lehberger, Newark, N. J. Undercarriage or Chassis for Flying Machines.

1,230,045. Filed Feb. 25, 1913. To Vladimir Skrivanek, Ft. Wayne, Ind. Flying Machine.

1,229,410. Filed Jan. 4, 1916. To John R. Campbell, Austin, Tex. Airplane.

1,229,713. Filed Apr. 24, 1916. To Geo. A. Chaddock, Broad Green, Liverpool, Eng. Mechanical Air-Borne Ship.

1,229,649. Filed Feb. 20, 1917. To Lafayette Pace, LaFollete, Tenn. Safety Appliance for Airplanes.

ISSUED JULY 10, 1917.

1,231,387. Filed Apr. 4, 1916. To Joseph H. F. Laflamme and Omer Gravel, Toronto, Ont., Canada. Bomb Dropper.

1,231,881. Filed Mar. 9, 1917. To Isaac Francis Taylor, E. Dulwich, London, Eng., assignor of one-half to Samuel Peck, London, Eng. Aerial Apparatus for Defense against Hostile Aircraft and for Other Purposes.

1,231,444. To Ruler William Spruger, Springfield, Ill. Wing or Propeller for Aerial Dynamics and other purposes.

ISSUED JULY 17, 1917.

1,232,313. Filed February 10, 1911. To Wilson S. Howell, Jr., New York, N. Y. Aeronautical Device.

1,232,616. Filed Jan. 30, 1913. To George C. St. Louis, Fresno, Cal. Airplane.

1,233,820. Filed Nov. 10, 1916. To Joseph B. Stage, Bold Spring, Tenn. Airship.

1,233,982. Filed Oct. 19, 1916. To Frank Clark, Throop, Pa., assignor of one-half to William Welton, Throop, Pa. Aeronautical Machine.

ISSUED JULY 24, 1917.

1,234,151. Filed May 17, 1915. To M. M. Goldenstein, Milwaukee, Wis. Motor Controller.

1,234,311. Filed Feb. 24, 1916. To Thomas Smith Duncan, Crayford, Eng. Landing Device for Airplanes and Hydroairplanes.

Testing Moisture Content in Lumber

By Thomas D. Perry

All lumber contains moisture, absolutely dry lumber being impossible, commercially speaking. In small test pieces, or on a laboratory basis, perfectly dry lumber can be obtained. Perfect dryness (often called "bone dry") is a condition in which all moisture has been evaporated, leaving only dry fibre and a minute amount of granular residue from sap (nearly negligible and disregarded hereafter). Lumber with a moisture content (indicated by m. c.) of 5 per cent means that in addition to the dry fibre weight the board contains 5 per cent of water (by weight), or a total of 105 per cent weight compared with 100 per cent dry fibre. In other words, one-twentieth of the dry fibre weight represents the additional weight of water.

There are three principal reasons for testing the moisture content of lumber, as follows:

1. When you buy lumber to be sure you are receiving what you bargained for.
2. When you put lumber in the kiln to ascertain the period of time necessary for drying.
3. To insure properly dried lumber before emptying the kiln.

To prepare for testing a lot of lumber, take a board from the wettest or greenest lumber as it is piled, cut off a piece 24 inches to 40 inches long and dress both edges, calling this a "test board."

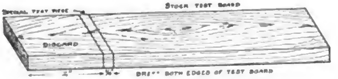


FIG. 1

If the test is preliminary to kiln drying, the test board should be put on a kiln car in such a location that it can be removed through instrument openings in side wall, door or end of kiln. From this stock test board several sections must be taken at intervals in the manner described. (See Fig. 1.)

Cut off about two inches of one end, which always reject, and take another cut ¼ in. long (way of grain) to be used as a special test piece to ascertain condition of lumber. Smooth off edges and corners with a coarse file or sand-paper. One or more test pieces should be prepared as lumber enters kiln, and others as it is thought lumber is ready for removal. When test shows proper per cent of moisture content it may be taken from kiln.

Computation Method Using a Metric Scale

For convenience in figuring the percent of moisture content, scales should be graduated on the decimal system, metric

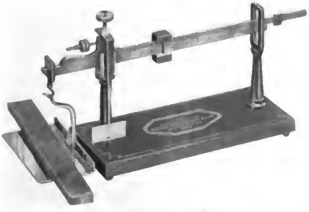


FIG. 2. THE METRIC SCALE

scales answering this requirement admirably. Fig. 2 shows a type of scale especially designed for weighing the lumber, equipped with sliding poises, and without the loose weights that are so liable to be lost. This scale, however, requires computation on the part of the user, and is, therefore, subject to the possibility of human error. The test pieces are to be marked as shown in Fig. 3. The figures above the line indicate the initial weight and measurement taken immediately after cutting out the test piece. The test piece is then reduced to "bone dry," or until it has reached the minimum weight on

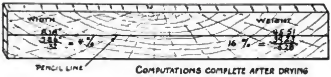


FIG. 3

a heater or radiator. While still hot re-weigh and re-measure, placing final figures below the line. The process of figuring is as follows:

SHRINKAGE		WEIGHT	
Before drying	8.18 in.	Before drying	45.51 grams
Bone dry	7.86 in.	Bone dry	39.23 grams

```
        7.86).3200(.04          39.23)6.2800(.16
              3144                    3.923
              ----                    ------
                56                    2.3570
                                      2.2638
                                      ------
                                         832
```

= 4%	= 16%
Expansion over bone dry.	Moisture content over bone dry.

The Computing Scale or Lumber Tester

This is similar to the preceding, but has a chart etched on the scale beam, as shown in Fig. 4, so that moisture content

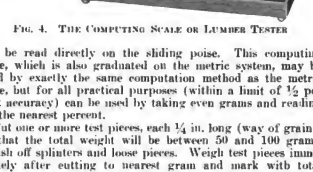


FIG. 4. THE COMPUTING SCALE OR LUMBER TESTER

can be read directly on the sliding poise. This computing scale, which is also graduated on the metric system, may be used by exactly the same computation method as the metric scale, but for all practical purposes (within a limit of ½ per cent accuracy) can be used by taking even grams and reading off the nearest percent.

Cut one or more test pieces, each ¼ in. long (way of grain), so that the total weight will be between 50 and 100 grams. Brush off splinters and loose pieces. Weigh test pieces immediately after cutting to nearest gram and mark with total weight. Reduce all test pieces to bone dry on engine cylinder, in oven, or on electric heater, until a constant or minimum weight is reached. Re-weigh the identical samples immediately after removing from heat and leave poise at exact weight to fraction of gram. Place pencil or other pointer on chart line at initial weight and follow down and left to final weight where poise stands. The point where chart line meets percentage scale on poise will give moisture content percentage reading on poise. The chart is drawn so that moisture content percentage is computed on basis of bone dry weight, as approved by the Forest Products Laboratory, maintained by the United States Government at Madison, Wis.

To use for exact results the initial weight must be brought to an even gram by slight sandpapering, even though several trials are necessary.

The percentage graduations on poise have finer divisions for percentages under 10 percent, since closer results are required in testing kiln dried stock within this range. Above 10 percent the divisions are for air dried and green stock.

The advantage of the computing scale is its freedom from error in subtraction and division. Anyone can use the scale, the simplicity of its operation encourages frequent testing, and frequent testing means uniformly dried lumber. Avoid charts, tabulation, or scales in which the computation is based on the initial rather than the final or bone dry weight.

Lumber at best is a variable material, due to processes of growth, and every provision should be given workmen to encourage them in keeping lumber dryness uniform in the woodworking shop.

Purchasing lumber on a moisture content basis is now receiving merited recognition. Green or partly air dried lumber that requires excessive kilning, or even yarding preliminary to kilning, is worth less than well air dried lumber ready for use after a minimum time allowance for kilning.

Lumber is valuable according to the speed with which it can be converted into a finished product. A price penalty for high moisture content in lumber bought and a bonus for a low moisture content would be beneficial to buyer and seller alike. Proper instruments efficiently used will make this possible.

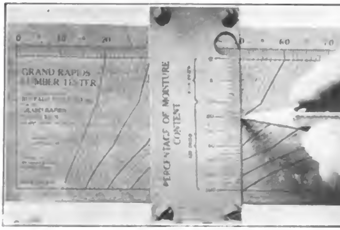
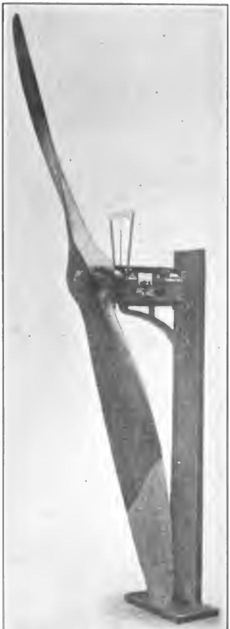


Fig. 5

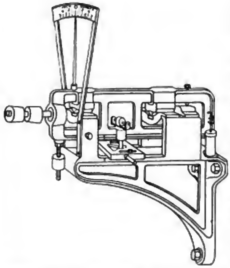
The Avery Propeller Balancing Machine

(From the *Automobile Engineer*)

This machine is designed to supersede the rough qualitative methods usually employed for propeller balancing. It consists of a rocking head having at one end a boss on which the propeller to be tested is mounted, and carrying three knife edges, two pointing upwards and one pointing downwards but all lying in the same straight line. The center of gravity of the head is below the line of the knife edges, so that the moment of unbalance of the propeller is resisted by a moment due to the weight of the head itself. A pointer is fixed to the head, and swings across a fixed scale, recording the amount of unbalance in inch-pounds. The knife edges bear on a bracket attached to a pillar, as shown in the photograph.



A General View of the Machine



Perspective Arrangement of the Balance Head

By the use of this machine it becomes possible to entirely avoid cut-and-try methods of adding and removing weight, the exact change which must be made at a given radius being deducible from the scale readings. It may also be employed in balancing the laminations separately before gluing, the effort being made to so arrange the laminations that their lacks of balance will counteract each other, removing the necessity for any weighting or removal of material from the complete propeller.

New City Planning Problems

City planning ideas have been greatly changed, if not revolutionized, by the war. Airplanes and the added needs of transportation and distribution have been partly responsible for this, and there is a note of inspiration in the statement, made by George B. Ford in an article in the *American City*, that France, for example, is going ahead, despite the war, with an extensive program of reconstruction against the coming time of peace. Ruined cities are being rebuilt along modern lines, and older cities are being made over. The French hope for lasting peace, but they propose to profit by the lessons of the recent past and to be ready for any emergency.

It is now seen that the city of the future will require provision for aviation. We may be slow to realize the fact here in the United States, but it will be impressed upon us later, for we propose to take a prominent part in the coming air campaign, and it is inevitable that when we are more familiar with this means of locomotion we will not return to the old ways. Thousands of airplanes will be flying in this country within a few years, Mr. Ford predicts, and the Postoffice Department already, in conjunction with the Aero Club of America, is planning to select appropriate places for landings in or near every important center. In France, aviators from a standing start, go only about 150 yards before leaving the ground, and then shoot up at a surprisingly sharp angle, but they require a field of about thirty acres on which to make a safe landing. Not many cities in the United States are well provided with open spaces suitable for such landings.

The importance of moving large numbers of people quickly from one place to another is accentuated by war, but it is nevertheless not to be disregarded in peace time, while the necessity for extending terminal facilities of every kind is especially impressed upon us by the National crisis. Not only railroads but watercraft require more room for taking on and discharging freight. This fact has been so realized by the French that the important ports are being reconstructed on a large scale. Facilities are being doubled, and in some instances even quadrupled, in size. "Hardly a city in America," remarks Mr. Ford, "is prepared to meet emergency conditions in like fashion." And it is probable that our emergency in this regard will come not because of the war but as the result of peace, when every forward-looking man believes that our trade in materials for the reconstruction of Europe will be increased enormously.

War has emphasized the need of city planning along intelligent lines. It has exposed shortcomings here and suggested improvements there. Even the need of suitable recreation has been emphasized. But greatest stress, if we except the problem of the airplane landing, has been laid on the high importance of docks and railroad terminals, of roads connecting cities, of warehouse facilities and of labor-saving devices for loading and discharging cars and ships. Of these, it would seem, there is no danger of having too much; and American cities, still in a comparative beginning of their growth, can save billions of dollars by taking the lesson to heart in time.

Bureau of Standards Test on Ackerman Wheels

Some recent tests have been made at the Bureau of Standards on the 26 x 3 in. Ackerman wheel, weighing 22 lb. complete.

The tests were made (a) to determine maximum component parallel to the axis, (b) to determine maximum component perpendicular to the axis, and the hysterisis, if any.

Test (a) was performed by holding the hub rigidly and applying the load at the edge of the rim, as shown in Fig. 1. Test (b) is not illustrated, but a similar method was used, the hub rigidly held and the load applied at the top of the rim.

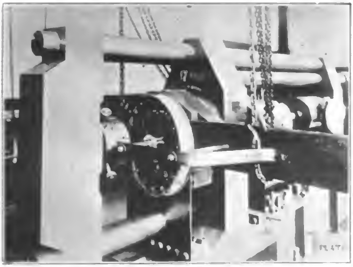


FIG. 1. ARRANGEMENT OF WHEEL ON TEST TO DETERMINE MAXIMUM COMPONENT PARALLEL TO THE AXIS

As shown in Fig. 1 on the first test (a), two bolts marked (x) broke at root of threads. This allowed spokes to slip out, which, in turn, broke the nickle-plated hub plate.

In the second test (b), two spokes broke by bending, and the rim and spokes were permanently distorted.

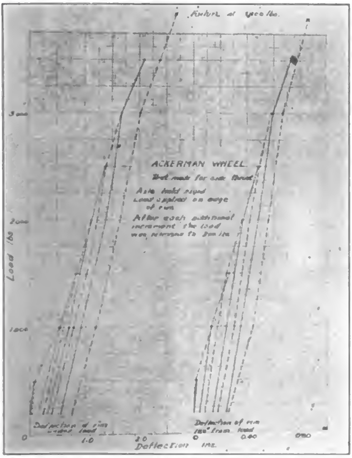


FIG. 2

In each test the load was released after an increase of 500 lb. over that of the previous load. In test (a), measurements were made between punch marks on rim and foundation channel. One set of marks was immediately under the point of application of the load, and another was 180 deg. from this point. Measurements for test (b) were made from the rim to a point on the hub directly under the load and 180 deg. from same.

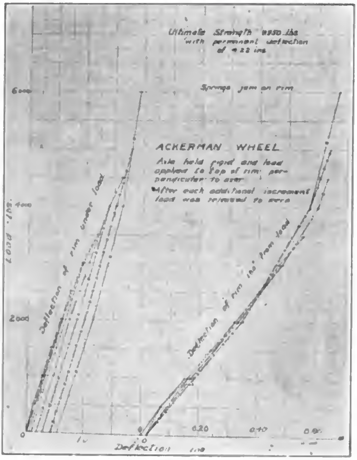


FIG. 3

In Fig. 2 are shown curves for test (a), in Fig. 3 those for

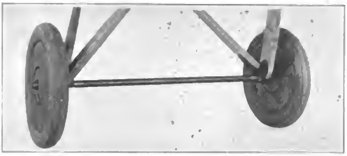


FIG. 4

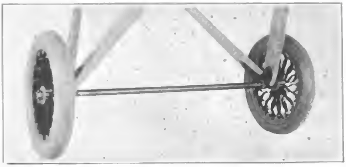


FIG. 5

test (b). After each loading and release there appears to be a set, but the return loop is not shown, so that the hysterisis work cannot be computed. This does not, however, appear to be considerable. The ultimate strengths were 3,800 lb. and 8,950 lb. for the two tests. With these curves in hand, the designer can compute exactly what occurs under any shock on landing.

Figs. 4 and 5 show the simple mounting of this wheel on the axle.

Excellent performance has been secured with this wheel in actual field tests in landing, getting away and running over uneven ground. A test made February 13 last at Mineola, L. I., by Capt. A. W. Briggs, formerly of the British Royal Flying Corps, is thus described in a letter from Captain Briggs:

"In a test flight today at the United States Aviation Field, Mineola, Long Island, I flew a Curtiss type J.N.4 military biplane No. 76, equipped with Ackerman wheels. The test was to determine the qualities of the Ackerman wheel.

"After making several landings in bad ground, stalling and dropping 5 to 6 ft. upon several of the landings, and then taxi-ing rapidly over very rough surface, I wish to say that the wheels proved to do all that was claimed for them and more, as their resiliency perfectly absorbed all shock before it reached the axle, causing the machine to hold the ground after a drop, and have little or no tendency to bounce as is the usual case in such landings.

"Over bad ground the uneven surface was, to all intents and purposes, smoothed out causing easy riding to the machine."

National Physical Laboratory Report for 1916-17

The annual meeting of the General Board of the National Physical Laboratory was held at the Laboratory at Teddington, Eng., June 19th. The President of the Royal Society (Sir J. J. Thomson) is chairman of the board, and Lord Rayleigh is chairman of the executive committee.

During the past year the laboratory has been closely engaged—with a largely augmented staff, of whom more than one hundred are women—with a variety of researches and investigations arising out of the war, and has dealt with a greatly increased volume of test work for government departments. Out of the wealth of reports we select the following, dealing with or bearing upon aeronautical work:

The Effect of Surface Roughness on the Heat Transmitted from Hot Bodies to Fluids Flowing Over Them

According to the Reynolds theory of heat transmission the heat transmitted from a hot surface to a fluid flowing over it for a given velocity of flow and difference of temperature is proportional to the frictional resistance between the fluid and the surface. Previous investigations at the laboratory and elsewhere have fully demonstrated the truth of this theory for the cases of commercially smooth surfaces, and owing to the considerable attention which is now being devoted to increasing the efficiency of radiation of air-cooled engines, it was considered to be of importance to determine whether the considerable increase in frictional resistance which would be obtained by artificially roughening the surface would be attended by a corresponding increase in the heat transmitted. The necessity for such an experimental investigation is apparent from the consideration that the Reynolds theory is based on the convection of heat due to turbulent motion, and that in cases in which the resistance is due to eddies on a larger scale, such as those thrown off from the edges of a thin plate normal to the current, its application may not be valid. A series of heat transmission experiments was accordingly undertaken with two brass pipes identical in all respects except that in one the internal surface was in the smooth drawn condition in which it was received and in the other the internal surface was roughened by means of a screw-cutting tool so as to form a series of sharp ridges. Water was circulated through the pipes by means of a centrifugal pump provided with suitable speed regulation so that the mean velocity of flow could be varied from 15 to 100 cms. per second. The outside of the pipe was surrounded by insulated coils of Eureka wire connected to the supply mains through variable resistance, and so arranged that the temperature of the pipe could be maintained at the desired value above the temperature of the water. The mean surface temperature of the pipe was measured by an extensometer specially designed for the purpose. For the estimation of the initial and final temperature of the water, thermojunctions in thin brass tubes were placed in the water at the extremities of the experimental length and connected to a potentiometer. The estimation of the flow of water through the pipes was obtained from a carefully calibrated meter. Observations of the frictional resistance of the pipes were made by the usual method. The investigation is not yet completed, but sufficient evidence has been obtained to demonstrate that for the degree of roughness of the pipe used the Reynolds theory can be applied for all practical purposes.

Equipment

The new wind channels, 4 and 7 ft. in diameter respectively, which were reported to be almost complete at the close of the last annual period, have been in continuous use for almost the whole of the current year. In both it has been found possible to obtain air speeds of 80 ft. per second with the more powerful motors installed, and the steadiness of the current is quite satisfactory when the supply is steady. In the early months difficulties were experienced from very sudden changes in the frequency of the supply voltage to the laboratory, which caused much inconvenience. The steadiness has since been greatly improved by the supply company, and the electrical plant rendered suitable for accurate work by careful attention to the voltage regulator installed in the generator room of the division. In the evenings the control so obtained is sufficient to render unnecessary continuous hand regulation of the air speed during an experiment.

The channels and balances of the new equipment were carefully set up independently of results obtained in the older channels. The speed standard was, as before, the standard National Physical Laboratory anemometer calibrated on the whirling arm to the nearest 0.1 per cent. of velocity. After setting up in this way, a standard wing section was tested, and the results were found to agree with those in the earlier channels. The same accuracy of agreement was found in a comparison made by the Massachusetts Institute of Technology and by the Royal Aircraft Factory, who followed National Physical Laboratory methods. The absolute accuracy of the methods appears to be established as of a high order.

New methods of test have been developed during the year in order to deal with new requests; the difficulty of the experiments called for is steadily increasing, and greater complexity in the models has made it important to consider new methods of holding them, so as to get the necessary mechanical strength without undue aerodynamical effects, which may be large unless the utmost caution is observed.

It is believed that the new methods have now been established beyond the experimental stage, and will form part of the accumulated experience of the division.

Experiments on Airship Models

Much work on the resistance and stability of airships has been carried out during the year, both on the non-rigid and rigid types. The results when applied in practice have proved to be very valuable, having led to the economy of time which follows from the success of the first attempt.

Work on screens for the shielding of airships has also received considerable attention. The structure of eddies is very complex, but methods have been devised whereby the necessary observations and records can be made. The more advanced results of the investigation are now becoming available and will shortly reach the stage at which a report can be made on the motion of the air in the neighborhood of an airship shed and screen.

Further investigations have been carried out on the equilibrium of kite balloons in direct connection with their use on the full scale, and modifications have been indicated which are now commonly adopted.

Experiments on Models of Airplane Wings

The work on aerofoils has covered the usual field, which includes work on new sections, the effect of combinations of planes and, in particular during this year, the aerodynamic properties of triplanes. Deformations of wing form due to the sagging of the fabric have been reproduced on a model and the variation of wing characteristics dependent on such deformations has been determined.

Experiments on Complete Models of Airplanes and Seaplanes

The results in the 7 ft. channels have proved that the increased scale and speeds made available do not lead to appreciably different results from those obtained in the smaller channels. The advantages of a larger section of channel are considerable in dealing with complete model airplanes as the mechanical accuracy of construction can be carried to further length.

The number of tests on complete models has again been considerable, and recently two very accurate and complete models have been constructed, one at the National Physical Laboratory, and the other at the Royal Aircraft Factory, on which work will continue for comparison with full scale observation of stability and performance.

The results so obtained are also useful for the calculation of the motion of an airplane when manuevering or when looping, conditions in which the aerodynamical conditions react directly on the stress problems connected with aeronautics. General methods of dealing with the strengths of air planes and propellers come up for consideration from time to time and where necessary the calculations are supplemented by additional experiments directed towards the determination of the forces acting. The conditions of flight are continually changing and are accompanied by fresh problems requiring solution.

Test on Airplane Bodies

The experiments under this head refer more particularly to the body as forming part of the whole airplane structure. The conditions of shape are fixed partly by aerodynamical considerations but on the whole more by the size of engine employed. The increase of resistance of the body due to the slip stream from the propeller is important, and for both pusher and tractor types has been made the subject of direct experiment.

Stability

In this section very little new ground has been broken, but the applications and detailed analysis have received much attention. Some work has been carried out on the stability of kites and kite balloons in addition to that of airships which has already been referred to.

Propellers

A number of propellers have been tested during the year, mostly in a wind channel, but occasionally on the whirling arm. The subject of the airflow round a propeller has been investigated from the point of view of design, and the investigation has led to an addition to the theory of design which is expected to ensure greater certainty in producing a propeller which is suitable for a special purpose. The work has given an explanation of a large part of the empirical design factors which have been used in the past. The theory in its new form has a direct bearing on the problem of the helicopter, and shows reason for large errors in applying the older methods of calculation to the problem of direct lift.

Special Investigations

During the year an analysis has been made of the performance of airplanes as measured by tests on the full scale. The conclusions reached are of very direct practical application, and it is hoped that they will lead to improved performance by directing attention to the salient features of importance in the design of a modern airplane.

Calculations have been made of the trajectories of aerial bombs, and the experiments on radiators have been continued.

Alloys Research

To a large extent, the work on aluminum alloys, which has been carried on throughout the year with the greatest possible energy, has been devoted to the immediate practical requirements of aircraft construction. A very large amount of work has been carried out and a long list of reports on a number of points of first-rate importance has been submitted, in the first place to the Advisory Committee on Aeronautics and to the various Admiralty and Army authorities concerned with aircraft construction. More recently the Advisory Committee on Aeronautics has formed a sub-committee to deal with light alloys, and on this sub-committee the laboratory is represented by the superintendent of this department. The work of this sub-committee is already making itself felt in a considerable increase in the amount and urgency of the work required of the department in connection with light alloys. At the same time it is gratifying to find that a considerable number of these results, thanks to the activity of the sub-committee and the representatives of the Air Board upon it, are finding immediate translation into practice. The work of the department in this connection may, therefore, reasonably claim to have assisted to a material extent in the development of the very marked improvements, particularly in aeronautical engines, which have been achieved during recent months.

During the year there has also been a marked revival in connection with those aspects of work on light alloys which have been carried on under the auspices of the Alloys Research Committee of the Institution of Mechanical Engineers. Much of this work overlaps and interlocks with the work required for immediate aircraft purposes, but, thanks to the grants from the Alloys Research Committee of the Institution of Mechanical Engineers, and, through them, from the Industrial Research Department, it has been possible to investigate a number of matters of broad and fundamental interest in connection with the whole question of aluminum alloys and their future use and development.

Offer Spruce for Airplanes

As a result of a conference held at Washington between authorized representatives of spruce manufacturers of Oregon and Washington and representatives of the Signal Corps, the Aircraft Production Board, the British, French, and Italian missions now in Washington, and the lumber committee of the National Council of Defense, Howard E. Jayne and F. A. Douty, of Oregon, proposed on behalf of the spruce men to furnish aircraft spruce for the coming year's big program at $105 per 1,000 feet. This price is about one-half that which has been paid up to now by many of the airplane manufacturers. The price applies to the allies' needs as well as to those of the United States.

If it is finally approved by Government authorities it will, in the opinion of the lumber committee, unquestionably result in a big saving on spruce requirements.

Specifications Proposed

The specifications which have been proposed by the spruce men and which received the informal approval of the Government's representatives present are as follows:

Thickness.—2 in. to 6 in., inclusive. At least 60 per cent to be 2 in. and 4 in. thick. Not more than 40 per cent 2 in., 5 in. and 6 in. thick.

Width.—All to be 4 in. and wider, not over 10 per cent under 5 in. wide.

Length.—Fifty per cent to be 19 ft. and longer. Fifty per cent to be 4 ft. and longer.

Measurement.—Width and thickness fractional. Lengths in multiples of 1 ft.

Grain.—All lumber 3 in. and thicker shall be not less than 70 per cent vertical grain of an angle of 45 deg. to 90 deg. on each carload. All lumber 2 in. thick shall be not less than 30 per cent vertical grain of an angle of 45 deg. to 90 deg. on each carload.

Grades.—The grades agreed to are as follows:

Grades Agreed Upon

The 50 per cent of all lumber 18 ft. and longer shall be clear four sides, straight grained, not less than six annular growth rings for each 1 in., sound and well manufactured, free from shakes, spiral and curly grain.

This grade will admit of bright sap, wane, pinworm holes, slight variations in sawing, or other defects that will not impair its usefulness for wing beams.

The 50 per cent of all lumber 4 ft. and longer shall yield clear cuttings, straight grained, not less than six annular growth rings per each 1 in., sound and well manufactured, free from shake, spiral, and curly grain; some may contain knots, pitch pockets, wane, pinworm holes, slight variations in sawing, and other defects that will not impair its use for the purpose intended, providing, however, that each piece must produce, for buyer, clear straight grain, cuttings from 4-ft. to 17-ft. lengths, which shall not include over 5 per cent of such cuttings 4 ft. to 7 ft., inclusive.

Anti-Aircraft Control System

A board of officers to consist of Maj. Elmer J. Wallace, Coast Artillery Corps; Maj. Charles T. Richardson, Ordnance Department; Capt. Jacob M. Coward, Coast Artillery Corps, Detached Officers' List; and Capt. George R. Allin, Field Artillery, Detached Officers' List, is appointed to meet at Fort Monroe, Va., at the call of the senior member to investigate and report upon anti-aircraft fire-control system which will be common to both branches of the Artillery.

$640,000,000 Appropriated for Army Aviation

On July 24 President Wilson signed the bill appropriating $640,000,000 for the enlargement of the Air Service of the Army. We give herewith two statements, one by Brig.-Gen. George O. Squier, Chief Signal Officer, and the other by Howard E. Coffin, chairman of the Aircraft Production Board, outlining as far as it is possible to do so, the plans of those charged with the expenditure of the appropriation:

Statement of Gen. Squier

"I am not here to make public our plans or to indulge in prophetic figures. The closest estimate I can give is about this: That the Allied Governments have determined to enter Germany by the air route and the United States Government is going to provide enough machines to make itself felt in putting this program through.

"That is not saying that we will construct 22,000 airplanes or 1,000,000 or ten or a dozen. If I knew how many machines we would or could construct in a year I wouldn't tell, because it would be telling von Hindenburg, and he'd thank us for the information. The best time to tell the enemy about any military program is after that program has been carried out.

"Germany announced her 42-centimetre guns by hauling them up to the battle line and firing shells of hitherto unheard of caliber into Belgium. After the guns were built and placed and in operation she encouraged the press in glorifying the results. The Germans are a nation of press agents, but they never let publicity tamper with a Government secret.

Air Route Into Germany

"Of course the public wants to know what we are going to do with the $640,000,000 which Congress has appropriated for the aviation service. Well, it's safe to say that we will spend that money and probably much more on the air route into Germany. That's about all we are going to say.

"Civilians are continually asking, 'What are your plans?' It's hard to convince some business men that an efficient military program is not a plan, but many plans. It ought to include all the plans there are in order to meet and defeat the fellow on the other side of the firing line, and you may be sure he has not been advertising his intentions.

"The public ought to be educated in the psychology of war, to be taught the swift opportunism which must be employed in carrying out any great military enterprise. The essence of strategy is surprise. In many respects war is the polar opposite of regular business, as business is generally considered. The captain of industry schemes out his work, sometimes looking years ahead. He plans to operate in settled communities, or communities whose growth and condition can be fairly well calculated. But the very spirit of warfare is shift, change, impermanency. A General on the field is working against a hidden foe whose science and wit are constantly employed for the wrecking of that General's plans.

"How, then, could I say, if I would, what America's aviation program will be for the next six months or a year? If you will show me von Hindenburg's provision for air attack during the coming winter and spring, then I might divulge a few Yankee plans to counter it.

Cost from $9,000 to $75,000

"People who are so cocksure about our determination to build 22,000 airplanes seem to be inspired with the notion that aeros are all made on the same pattern, turned out of the factory as alike as two cubes of sugar. As a matter of fact airplanes vary in cost between $9000 and $75,000; and a comprehensive aerial program must include everything from a simple school machine to a flying dreadnaught. New inventions are continually being tried out, new appliances and models must be installed in order to keep up with the times—or a little ahead of them.

"The German General Staff—that mysterious body working and thinking all the time somewhere between Berlin and Constantinople—isn't going to let things remain at a standstill over there, and we may be called upon to revise our whole system in order to wreck theirs. That is war, which, as I have explained, is the most elastic thing in the world.

"A recently cabled report quotes the German commander of aviation as saying that American aviators will fail, among other things, through lack of courage. That German, obviously, has never encountered an American flier in action."

Mr. Coffin's Statement

"The program must be carried out with a promptness equal to that displayed by Congress in passing the measure. It is a task demanding all the initiative and power of American industry for its consummation, and, just for that reason, one to which the nation will respond.

"All world's records for industrial development of a new art must be broken. Whatever crimes may later be laid at the door of those who are to direct this work, that of inaction or slowness in accomplishment must not be one of them.

"We are prepared to go ahead at once with the expanded plans which the appropriation makes possible.

"One word of caution only need be said here. Under ordinary conditions at least a year would be required for the industrial preparation which this program demands. Yet we have no such length of time in which to perform the task now.

"In spite of our previous inexperience in quantity production of fighting planes we must have thousands of them for next year's use to make the contribution which the allies expect of us.

Must Await Results

"It must be remembered, therefore, that a few months will necessarily elapse before the outward results of our industrial effort will show in the shape of quantities of finished fighting machines.

"It may be announced, however, that most gratifying progress on this preliminary organization already has been made during the last few weeks, and if it progresses in the future at the stride that has been developed there need be no fear as to America's position in the aircraft field by next summer.

"Within a comparatively short time we shall have enough of the type required for training the thousands of men who will constitute a contribution to the winning of the war equal in importance to the production of machines.

"America is the last great reservoir of material for war pilots as well as for airplanes. Already three of the twenty-four big new training fields are completed and instruction on them has begun. Others are being rushed to completion.

Orders Placed

"Orders for training machines were placed weeks ago, and shipments of the first output already have been made. The output of this most necessary type will continue to increase rapidly, as we already have plants experienced in their manufacture.

"One hundred and ten thousand officers and men—an army of the air greater than our standing army of a few months ago—will be needed. The whole project is one which appeals to the imagination of our people and to the genius of our American engineers."

Photo Central News Service

ANTI-AIRCRAFT GUN ON THE ITALIAN FRONT

Manufacturers Aircraft Association, Inc., Organized

In view of several erroneous statements which have been made in the public press, relative to the Manufacturers Aircraft Association, AVIATION prints the following statement issued by the Chairman of the Publicity Committee, Fay L. Faurote:

At a meeting held July 24 in the law offices of Crisp, Randall & Crisp, well-known patent attorneys, the air manufactures of the United States pooled their patent interests for the good of the Government and formed a new organization known as the Manufacturers Aircraft Association, Inc. By the terms of their agreement the various patents owned by the individual members are to be taken over and so cross-licensed that their use may be made universal to all engaged in the industry.

This action comes as a result of a number of conferences held in Washington by the members of the National Advisory Committee for Aeronautics and the officials of the Army and Navy and the Manufacturers Aircraft Association.

In January, 1917, the Secretary of War and the Secretary of the Navy requested the National Advisory Committee for Aeronautics to investigate the aircraft situation and recommend a solution for the problem in patent litigation which had arisen between the Wright-Martin Corp. and the Curtiss Aeroplane & Motor Corp. As a result of these meetings a special sub-committee on patents was established at a regular meeting of the Executive Committee on February 10, consisting of Charles D. Walcott, chairman; S. W. Stratton, S. D. Waldon, and Lieut. J. H. Towers, U. S. N. In May, 1917, Judge W. Benton Crisp, Frederick P. Fish (Mr. Fish was not able to serve, and therefore Charles Neave, his partner, acted in his place) and Dr. W. F. Durant were added to the sub-committee on patents, the latter serving as acting chairman.

Previous to this time, Howard E. Coffin, chairman of the Aircraft Production Board and a member of the Council of National Defense, and Sydney C. Waldon, of the Aircraft Production Board, had had several conferences with the aircraft manufacturers, and at the time of the Aeronautic Show in New York suggested an association which later was formed under the name of the Aircraft Manufacturers Association. Meetings were held in Washington on March 23, June 18 and July 10, 11 and 12, to which representatives of the aircraft manufacturers were invited.

After many weeks of consultation and deliberations between the interested parties an agreement was drafted by Mr. Crisp and Mr. Neave and reported to the Executive Committee of the National Advisory Committee for Aeronautics, which agreement was finally approved by the Executive Committee.

When these negotiations were started the task of bringing all of the parties interested together seemed insurmountable, but actuated by patriotic impulses it was finally agreed at the last regular meeting of the Aircraft Manufacturers Association held in Washington, that the cross-licensing agreement and license be completed, and a recommendation made for the formation of a corporation under the laws of the State of New York to be known as the Manufacturers Aircraft Association, Inc.

This recommendation was followed and for the purposes of keeping the organization free from partisan influences in order that the best interests of all stockholders thereof might be managed and directed during the first five years of its existence under a definite and fixed policy, it was decided to place the control of the association in the hands of three voting trustees, consisting of Judge W. Benton Crisp, Joseph S. Ames, professor of the Department of Physics of Johns-Hopkins University, whom it will be remembered was recently sent abroad by President Wilson as a member of a commission delegated to investigate scientific subjects, and Albert H. Flint, the vice-president of the L. W. F. Engineering Company and vice-president of the Aircraft Manufacturers Association.

Of these three, one represents the Manufacturers Aircraft Association, Inc., one the Curtiss and Wright interests, and the third is a neutral elected by the other two.

The directors of the Association are: Frank H. Russell, of the Burgess Co. of Marblehead, Mass.; Albert H. Flint of the L. W. F. Engineering Co.; John P. Tarbox of the Curtiss Aeroplane & Motor Corp.; Harry Bowers Mingle of the Standard Aero Corp.; B. S. Foss of the Sturtevant Aeroplane Co.; George H. Houston of the Wright-Martin Aircraft Corp.; H. E. Talbot, Jr., of the Dayton-Wright Aeroplane Co.

The officers of the Association are: Frank H. Russell of the Burgess Co., president; Albert H. Flint of the L. W. F. Engineering Co., vice-president; Harry B. Mingle, of the Standard Aero Corp., treasurer; Benjamin S. Foss of the Sturtevant Aeroplane Co., secretary and Benjamin L. Williams, assistant secretary.

Judge W. Benton Crisp, one of the trustees, well known as Henry Ford's attorney in the Selden patent case, the counsel for Curtiss in the Wright vs. Curtiss litigation and representative of the Hudson interests in the Hudson crank shaft case, was retained as general counsel.

By the terms of the cross-licensing agreement any responsible manufacturer of aircraft, or one who intends to become a bona fide producer of same, or any manufacturer to whom the United States Government has given a contract for the construction of ten more airplanes, or any person, firm or corporation owning or controlling United States patents relating to airplanes may become a party to the voting trust agreement, provided for in the by-laws, and can qualify as a member.

It is the purpose of the association not to curtail, but to open up the industry in order that the Government officials and airplane manufacturers may not at this time be under any improper or unfair restraints.

All patent litigation relating to airplanes between members of the association ceases automatically, and the airplane industry is therefore left free to expand to any limits desired or required by the unusual demands of the war.

Goggles for Aviators

A goggle designed for use by aviators has several interesting features, different from anything previously produced. The glass used in this goggle has been tested by the Underwriters' Laboratory of Chicago and by the Army and Navy and other Government Laboratories and found ideally suited for the purpose it is intended.

The glass is called "Resistal," and is manufactured by Strauss & Buegeleisen, Warren Street, New York. It is made of two pieces of glass with an intervening layer of celluloid, welded together in such a manner as to form one perfect whole, which is waterproof and not affected by any conditions of heat, cold or moisture. The edges of the glass are not sealed and nothing is used in the manufacture that is affected by moisture or air.

The glass is bent to conform to the curvature of the face and gives an extreme limit of side vision as well as an unobstructed vision in either direction. Less than five degrees of vision at the side are cut off by the goggle.

The frame is extremely comfortable, warm and durable and is made to fit any face. A cushion of rubber is mounted as a pad in addition to the usual velvet silk chenille providing a comfortable bearing.

If cracked by a blow or concussion, no particles become detached and there can never be flying pieces of glass, no matter how badly the glass may be hit. Even after it is cracked, it remains airtight and watertight. It does not discolor, scratch or distort the vision and is as transparent as an ordinary sheet of glass.

This glass can also be made in any desired colors, such as amber, euphos or smoke.

Major Foulois Head of Airplane Division

Major Benjamin D. Foulois has been named chief of the airplane division of the Army.

(C) American Press Association

CURTISS FLYING BOATS IN ACTIVE SERVICE

New Curtiss Flying Boat

The new Curtiss model H S-1, a flying boat built for coast patrol work, had its trial flight July 24. Piloted by Harold Kantner, with Wallace Bugh as passenger, the machine left Buffalo at 9.15 a. m., arrived at the Toledo, Ohio, Yacht Club at 1.05 p. m., left Toledo at 5 o'clock and landed at the Detroit Motor Boat Club at 6 o'clock.

On the return trip the next day, in face of a head wind, and with weather conditions so foggy that the pilot was compelled to follow the winding American shore of the lake, and with no attempt at speed, the machine, which left Detroit at 9.15 a. m., arirved at Angola, on the outskirts of Buffalo at 2.40 p. m.

The new model is powered with a 200 h.p. Curtiss engine, which worked perfectly on the trial flight.

Manufacturer's Specifications

General Dimensions:		
Wing span—upper plane..		59 ft. 4 in.
Wing span—lower plane..		45 ft. 8 in.
Gap between wings.......		90 in.
Depth of wing chord.....		75 1/16 in.
Stagger		0 deg.
Length of machine, overall		38 ft. 6 in.
Height of machine, overall		14 ft. 3 in.
Angle of incidence.......		4 deg.
Dihedral angle..........		0 deg.
Wing curve..............		R.A.F. No. 6
Areas:		
Wing, upper.............		370 sq. ft.
Wings, lower............		256 sq. ft.
Ailerons, each..........		54 sq. ft.
Rudder		25 sq. ft.
Elevators, each.........		24.9 sq. ft.
Vertical stabilizer......		34.9 sq. ft.
Horizontal stabilizer.....		63.9 sq. ft.
Total supporting surface.		626 sq. ft.
Loading (weight carried per sq. of supporting surface)		6.7 lb.
Weights:		
Net weight — machine empty		3215 lb.
Gross weight — machine and load............		4205 lb.
Useful load..............		990 lb.
Fuel, 100 gal...	610 lb.	
Oil, 8 gal...	60 lb.	
Passenger	160 lb.	
Pilot	160 lb.	
	990 lb.	
Performance:		
Speed, maximum.........		73 m.p.h.
Speed, minimum.........		52 m.p.h.
Climbing speed (from actual test)............		500 ft. in 3 min.
Engine:		
Model		V 2-3
Horsepower (rated at 1400 r.p.m.)		200
Weight per rated hp.....		3.45 lb.
Fuel consumption per hour per brake hp.........		.54 lb.
Fuel tank capacity......		100 gal.
Oil tank capacity........		8 gal.

W. A. Morgan Manager of Curtiss Co.

William A. Morgan of Buffalo, retiring president of the Buffalo Copper & Brass Rolling Mill Company, becomes the vice-president and general manager of the Curtiss Company in general charge of its business and operations.

John N. Willys of the Willys Overland Company has been elected president of the Curtiss Company. Mr. Willys has also been elected a member of the executive committee to succeed Harry Evers of Buffalo, resigned.

Mr. Morgan's record in handling the phenomenal growth of the Buffalo Copper & Brass Rolling Mill Company under its strenuous war demands is high evidence of his ability to meet the requirements of the Curtiss Aeroplane Company's coming expansion.

Aviation Boards Appointed

A board of officers to consist of Maj. Henry H. Arnold, junior military aviator, Signal Corps; Capt. Henry W. Harms, junior military aviator, Signal Corps, and Capt. Lewis H. Brereton, junior military aviator, Signal Corps, is appointed to meet in Washington at the call of the senior member for the purpose of examining such officers of the aviation section of the Signal Corps as shall appear before it to determine their fitness for rating as junior military aviators.

A board of officers to consist of Lieut. Col. William Mitchell, aviation section, Signal Corps; Capt. Millard F. Harmon, Jr., junior military aviator, Signal Corps; and Capt. Davenport Johnson, junior military aviator, Signal Corps, is appointed to meet in Paris, France, at the call of the senior member for the purpose of examining such officers as may appear before it to determine their fitness for rating as junior military aviators.

Prof. L. S. Marks to Have Charge of Engine Investigations

The National Advisory Committee for Aeronautics has just secured for an indefinite period the services of Prof. Lionel S. Marks, head of the combined departments of Mechanical Engineering of Harvard University and Massachusetts Institute of Technology. He will be assigned to assist in the special work of the Sub-committee on Power Plants, and will, have charge of certain investigations relating to airplane engine design conducted by this committee at the Bureau of Standards.

Professor Marks is a recognized expert in thermodynamics, engine cycles, and particularly the gas engine, and is probably the best qualified man in the country to supervise the important investigations proposed.

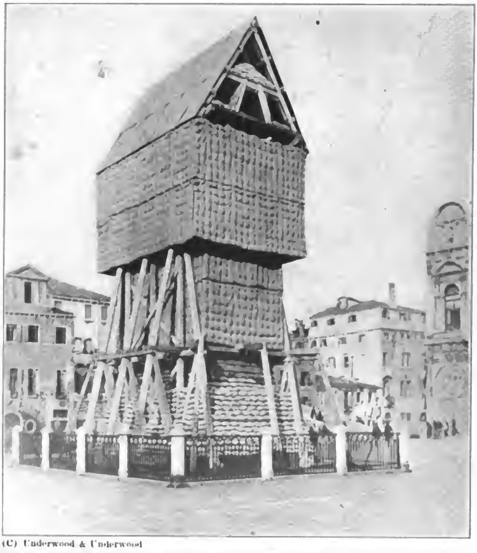
Army Wants Aviation Observers

It is desired to obtain in service in the Aviation Section, Signal Officers' Reserve Corps men qualified for training and commission as observers from airplanes. Candidates for this position should be from twenty-five to thirty-five years of age, should have a good education and be physically fit. Keen eyesight is essential. Ability to draw, and judge distances are desirable features. He should be well balanced and have good judgment, and if possible previous military experience.

It will be the intention to assign successful candidates to a school for periods of instruction of from three to four months. This course of instruction will cover study of artillery, fire from airplanes, reconnaissance, photography, radio and bomb dropping.

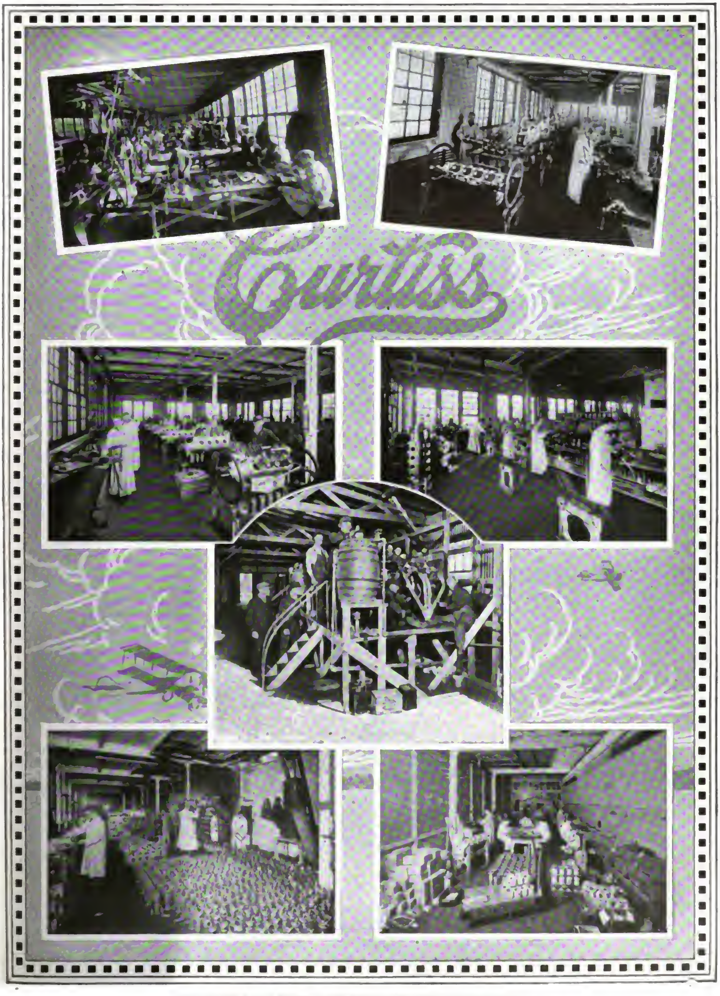
Candidates who desire to make application for this position should write to Airplane Division, Chief Signal Officer, War Department, Washington, D. C., who will furnish them the necessary information and blanks for making application to take examination.

Candidates who complete the course successfully will be commissioned as First Lieutenant, and will be eligible to promotion. The pay carried by this commission is $2,000 per year with an increase of 25 per cent when engaged in the duty of observation officer.



(C) Underwood & Underwood

THE COLLEONA MONUMENT IN VENICE PROTECTED FROM AIRCRAFT ATTACK BY SAND BAGS



THE CURTISS AEROPLANE AND MOTOR CORPORATION, BUFFALO, N. Y.
Member Aircraft Manufacturers' Association, Inc.
America Trans Oceanic Company, 280 Madison Ave., New York City, New York Agents

AEROL

A practical quality oil for aeroplane motors

There are all kinds of watches —from a dollar up.

There are watches built to stand hard, rough usage. There are very fine watches built for extreme accuracy and dependability.

* * *

There are all kinds of gasolene motors, from a one-cylinder farm motor to the finest aeroplane engine.

* * *

Because of its very fineness, a good watch is easier to keep running accurately than a poor one.

Likewise, an aeroplane engine is many times more dependable than its cheaper brother.

* * *

The lubrication of an aeroplane motor, because of its very fineness, should be less of a problem than the lubrication of an automobile motor.

THE problem of aeroplane motor lubrication, resolved into its simplest terms, is this:

"To lubricate an exceptionally fine motor operating continuously under maximum load."

Hence, we have produced AEROL—not an oil of mystery—but a practical quality lubricant based on conditions to be met (except for rotary motors).

AEROL is, first of all, a very high grade oil, free from impurities.

Its lubricating values are very high, because it is an exceptionally good oil, made from a good crude to begin with, by a process developed through years of knowing how.

The drop in viscosity with the increase in heat is (relatively) unusually small. It is made in three grades of viscosity to meet the requirements of different types of motors.

AEROL is a practical oil because it is easily handled and flows easily. This feature is of practical utility where oil is drained off and cleaned out frequently. Also, where external feed systems are used.

Full details, characteristics and tests will be furnished to government officials, aeroplane manufacturers and others interested in the subject of aeroplane motor lubrication.

Technical and Research Department

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DYNAMIC BALANCE

for crankshafts, etc.

Send for pamphlet describing my latest *Dynamic Balancing Apparatus*

MODEL 1917

It is just as scientific as was my last year's model (*not now made by me*), although entirely different in principle and construction, much cheaper and yielding still better results.

No Agents, Representatives or Licencees!

Made and Distributed EXCLUSIVELY by

N. W. AKIMOFF, Harrison Building, Philadelphia

(Originator of the Dynamic Balancing Machine still known by his name.)

What Would You Think of a Manufacturer—

—who wrote to you with a stub pencil—"We are saving much money because we do not use typewriters and telephones"? You might well wonder whether his merchandise was as much out of date as his business methods.

You know that modern time and labor saving appliances are not added expenses, but that they have superseded slower and more costly processes.

The concern that uses your business paper to tell you its business story is simply making it easier for you to buy intelligently with the least waste of time on your part and theirs.

For the right kind of advertising shortens the distance between human minds just as certainly as the railroad has shortened the distance between places. It is still possible to walk from New York to Chicago, and it is still possible for a business to get along without advertising, BUT—

—don't forget that the seller who does not advertise, is not only paying for the results that such advertising would get him, but he is also *paying more than necessary.*

Progressive advertisers are progressive merchandisers and it pays to do business with them.

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Coal Age
Concrete
Domestic Engineering
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Dry Goods Economist
Dry Goods Reporter
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Electrical Railway Journal
Electrical Review & Western Electrician
Electrical World
Electric Traction
Engineering & Mining Journal
Engineering News-Record
Farm Machinery—Farm Power
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Hotel Monthly
Illustrated Milliner
Implement Age
Industrial Arts Magazine
Inland Printer
Iron Age
International Trade
Lumber Trade Journal
Lumber World Review
Manufacturers Record
Manufacturing Jeweler
Marine Engineering
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Metallurgical & Chemical Engineering
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Motor Age
Motor World
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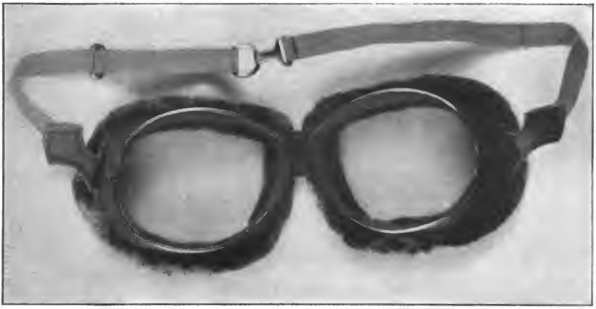

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AVIATOR'S GOGGLES

Unbreakable

Resistal goggles are equipped with unbreakable lenses. **No glass will fly from *Resistal* lenses from a blow sufficient to shatter an ordinary lens.**

These lenses are made of a layer of transparent celluloid welded under enormous pressure between two layers of the finest glass, giving 97.64% of transparency and at the same time subduing some of the glare.

Bent for Side Vision

Resistal lenses are bent for side vision, increasing the range of sight of the wearer.

As the layer of celluloid acts also as an insulator, vapor **will** not **gather** on *Resistal* lenses.

Water-proof No adhesive cement is used in their construction, with the result that water has absolutely **no effect** on *Resistal* lenses.

Tested *Resistal* lenses have been subjected to the most rigid tests, and comply fully with the regulations of the Army and Navy.

Prompt Delivery can be had in any quantity. Write us direct for full information and prices.

Strauss & Buegeleisen

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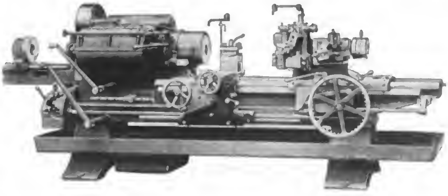
WALDEN-HINNERS COMPANY

BUILDERS OF AIRCRAFT

MILITARY AIRPLANES
SEAPLANES
FLYING BOATS

OFFICE AND FACTORY
EDGEWATER, N. J.

Note how thin and close together the cooling fins are, requiring very careful forming.



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reduces vibration and eliminates bearing pressure

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LUMBER TESTER

KNOW the MOISTURE CONTENT of your LUMBER

DIRECT READING—NO COMPUTATION—NO GUESSWORK

All air-dried lumber for AIRPLANES should be tested to insure uniformity.

Lumber should contain from 5 to 10 per cent. moisture for manufacturing purposes, according to kind of work.

Lumber containing less will absorb moisture from the air and expand.

Lumber containing more will expel the surplus and shrink.

Determine time required for drying by testing before loading kiln.

Determine if lumber is dry by testing before "pulling" kiln.

The Grand Rapids Lumber Tester is based on "bone dry" or constant weight and is scientifically correct, according to the standards of the U. S. Forest Laboratory at Madison, Wisconsin.

GRAND RAPIDS VAPOR KILN

Manufactured by GRAND RAPIDS VENEER WORKS
Grand Rapids, Mich. Seattle, Wash.

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CLOCKS
FOR USE ON
AEROPLANES *and*
SEAPLANES &c.

The Justly Celebrated
8 DAY—HIGH GRADE
"CHELSEA"

CORRESPONDENCE SOLICITED

CHELSEA CLOCK CO.
10 State Street, Boston, Mass., U.S.A.

From an actual night photograph without retouching.

Taken with no light except the glow of Marvelite itself.

Aviation Barometers Equipped With

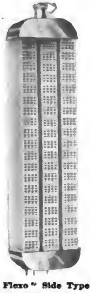
MARVELITE

self-luminous Radium compound of quality

Are proving so useful and so entirely satisfactory that no manufacturer can longer afford to delay investigating the merits of this remarkable new material. Correspondence solicited, samples furnished and any reasonable demonstration gladly made for makers of barometers, compasses, sights, clocks and watches.

COLD LIGHT MFG. COMPANY
DENVER, COLORADO

AUTO RADIATOR MFG. CORP.
Flexo
LOS ANGELES CALIFORNIA



"Flexo" Side Type
Used by the U. S. Government

Having just completed large orders for the Allies we are in better position than ever to take care of our trade

AUTO RADIATOR MFG. CORP.
219-225 W. 12th STREET, LOS ANGELES, CAL.

IN ACTUAL DAILY PERFORMANCE

In every branch of military service—Engineering Corps, Aviation Section, Quartermaster Corps, and general Patrol, Scout, and Dispatch duty—you will find the 1917

Indian Motocycle
With Powerplus Motor

Greatest strength, endurance, speed, power, accessibility, and all-round dependability.

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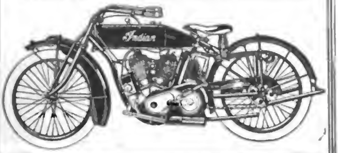

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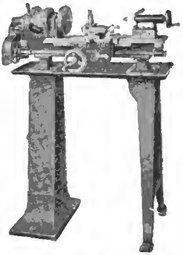

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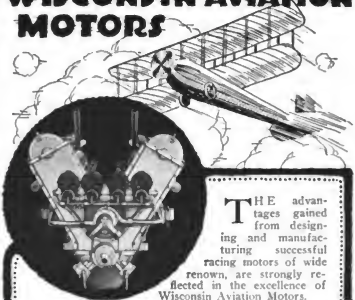

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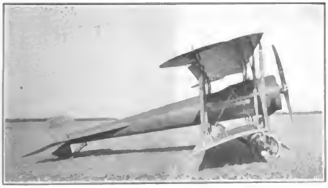

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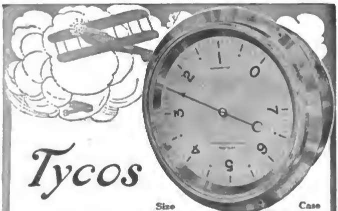

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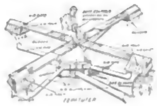

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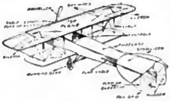

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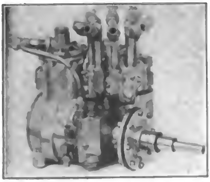

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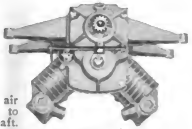

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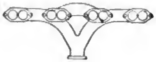

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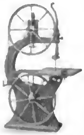

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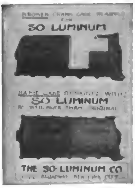

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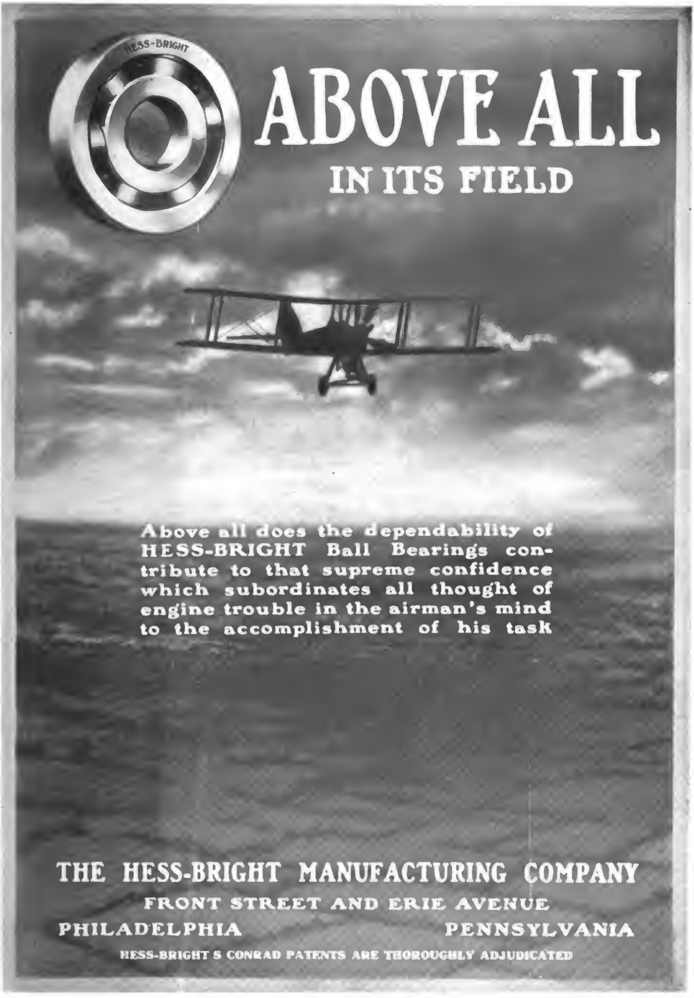

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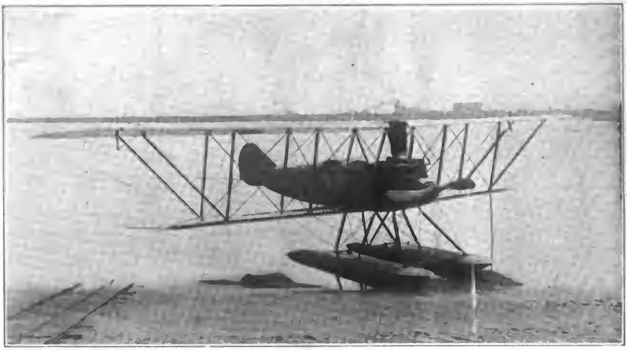

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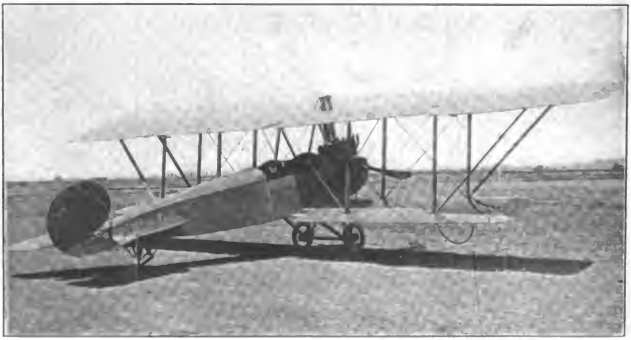

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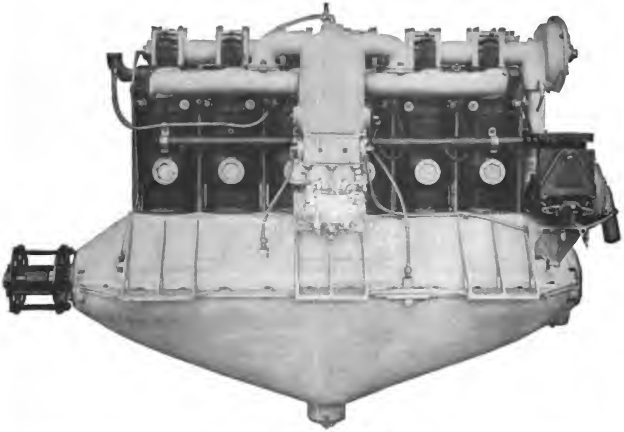

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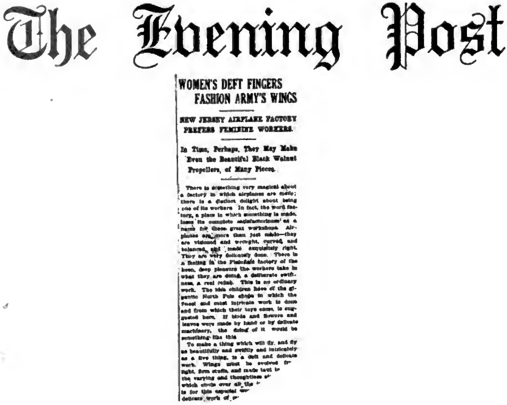

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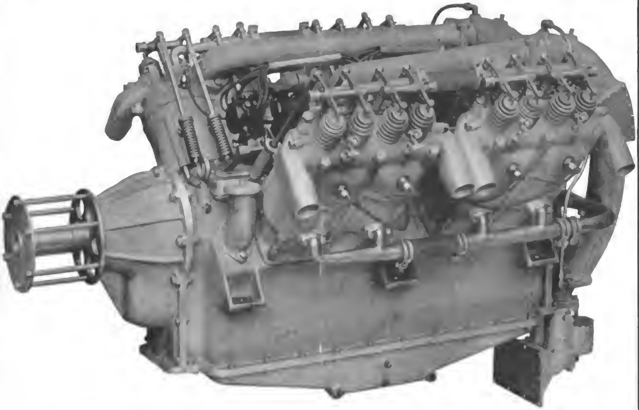

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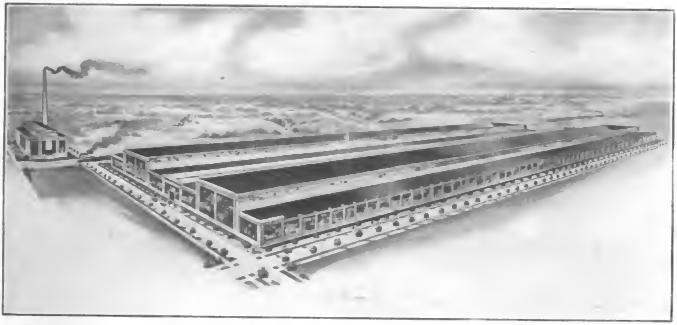

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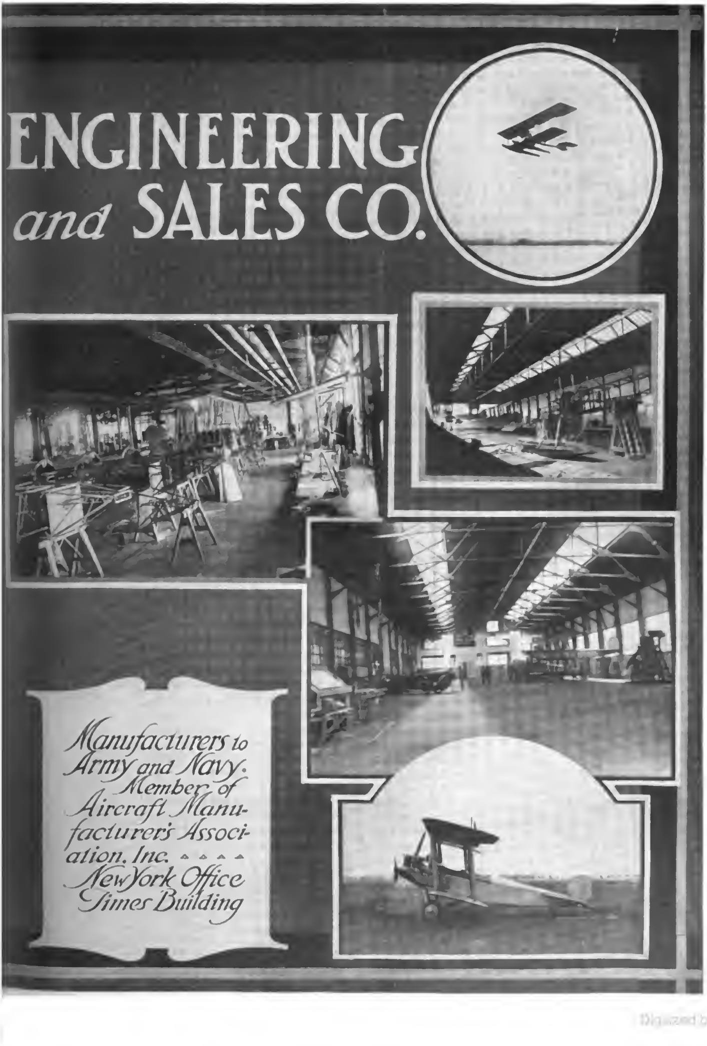

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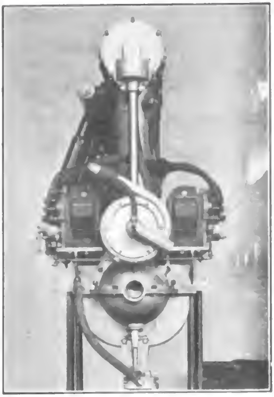

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AUGUST 15, 1917

VOL. III. NO. 2

AVIATION AND AERONAUTICAL ENGINEERING

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BUSINESS MANAGER
GEORGE NEWBOLD

Vol. III August 15, 1917 No. 2

THE problem confronting the small constructor of airplanes at the present time is serious and one likely to become increasingly difficult unless solved by the Aircraft Protection Board in a prompt and satisfactory manner.

The difficulties which the small constructor has encountered in the past have recently been further aggravated by the shifting of official authority which the process of expansion and reorganization of the United States Air Service has made an unavoidable necessity. Prior to the War, the Aviation Section of the Army endeavored to assist, within the modest appropriations granted it by Congress, the development of all available types of training and service aircraft. This policy encouraged the design, construction, and experimentation of many airplanes for military and naval purposes.

When the formulation of a war program was undertaken by the Aircraft Production Board, the requirements of our Air Services were found to have increased to such proportions that the available sources of supply of airplanes and engines would prove insufficient for the purpose. As a consequence large manufacturing concerns that had no previous experience in aircraft construction but possessed the skilled labor and the machinery required for quantity production had to be called upon so as to make possible the rapid construction of a huge air fleet.

This policy would be eminently satisfactory from the viewpoint of rapid production, if it took more into account the interests of the small manufacturer whose experience and expenditures entitle him to consideration. Large sources of supply and strict adherence to standard designs are obviously desirable and even indispensable for rapid production of aircraft. This is especially true where a type of aircraft is required which has not undergone radical alterations during the war, that is, training and reconnaissance machines.

But where standardization is likely to defeat its own purpose is in the construction of pursuit airplanes whose performances are bettered, now by the Allies, now by the Germans, from month to month, so that an airplane of this class is generally considered obsolete after only a few months of service. To improve constantly the speed and climb as well as the armament of pursuit airplanes the brains of our cleverest aeronautical engineers and draughtsmen should permanently be kept engaged on the problem; but to do this an airplane manufacturer needs a certain amount of steady orders which will enable him to run his factory if not with profit, at least with no loss.

It is understood that for the present the Aircraft Production Board believes in giving in preference orders to organizations which can make at least 600 machines per year, or about 12 per week. While there seems to be no desire or intention to stifle competition or favor the big sources of supply to the detriment of the small ones, the impression is created that there will be a period, however, during which chief attention will be paid to the large manufacturer in order to establish a certain amount of foundation work, so that quite some time may elapse before the small constructor will have a fair chance of success.

If a limited number of trial orders, spaced over a fair period, could be given to responsible concerns who have not the facilities of large manufacturers, it would doubtless result in creating an incentive which should have a decidedly favorable effect on the development of the American aircraft industry and the successful pursuit of the war.

The Battleship of the Air

In this issue our readers will find a description of the Handley Page twin tractor battleplane, which is propelled by two 270 horsepower engines, and carries three machine guns and eight bombs of 250 pounds each. The Caproni triplane with three 200 horsepower engines has an equal gun and bombing capacity. The new German Gotha, a biplane which bears evident traces of alterations inspired by the Handley Page design, and is equipped with two 270 horsepower Mercedes engines, seems equally well equipped from a fighting standpoint. It carries three machine guns, one of which can fire down through the body, enabling the crew to meet an attack from an opponent who would otherwise be masked by the tail surfaces.

We have been accustomed to theoretical discussions of the limiting size of airplanes. It is possible to demonstrate theoretically that, given machines of exactly similar design, if all dimensions increase in the same ratio the bending moments increase more rapidly than the resisting moments, so that a point is reached where further growth is impossible. But these machines are not of similar geometrical design. Thus in the Handley Page twin-tractor the wing rib construction breaks away from the standard lightened web construction of the small machine, and develops boldly a lattice girder construction, with the obvious advantages of a calculable and lighter rib structure. Similar improvements are probably possible at other points. Steel may be used in large machines where a paper thickness precludes its use in smaller airplanes. Thus the theoretical maximum size disappears.

Logarithmic Diagram for Selecting Propellers

By G. Eiffel

Abstracted from L'Aerophile by Thomas L. Blakemore

This article relates to a redetermination of the logarithmic propeller chart for eight of the screws for which the results were published in "Nouvelles Recherches sur la Résistance de l'Air et l'Aviation," 1914. The new series of tests was necessitated by the fact that the determinations of tare previously made were not sufficiently exact. Two direct methods for finding the tare have now been devised, and can be used as checks against each other.

The new logarithmic diagram is given in Fig. 1, as well as drawings of the eight propellers tested. For each one, log $\frac{Pm}{N^3 D^5}$ is plotted as a function of log $\frac{V}{ND}$ and the various propeller efficiencies obtained are marked on the curve at the propeller points.

The diagram permits us to choose the propeller which best suits the required conditions, knowing the velocity of translation, V, the power Pm of the engine, and the r.p.m. of the propeller, or the velocity, the power, and the diameter D of the propeller.

To make the choice, we proceed as follows: draw a broken line starting from the origin, O, and having segments equal in length to the values of D, r.p.m., etc., as measured from the points Or on the various axes of these quantities.

For example, the full broken line shows that in this case V is 90 m.p.h., Pm is 150 h.p., and N is 1350 r.p.m. To this broken line is added a segment parallel to the axis of diameters. The segment cut off by the curve of the propeller chosen, laid off from Or on the axis of diameters, measures the diameter of a propeller of this type which will be required to fulfill the given conditions, and the point of intersection with the propeller curve gives, by interpolation between the values on that curve, the propeller efficiency.

Selecting propellers Nos. 11, 24, and 8 to serve as examples we have the following values for required diameters:

Propeller No.	11	24	8
Diameter (ft.)	8.4	9.0	6.7
Efficiency (%)	75	74	66

The conditions given for the problem, the solution of which is represented by the dashed broken lines are: V-52.5 m.p.h., Pm-200 hp., and D-16 ft. 4 in. We then find the following values for the necessary r.p.m. for propellers Nos. 11, 24, and 8:

Propeller No.	11	24	8
R.p.m.	467	520	335
Efficiency (%)	72	72	65

From such a table as this it is easy to select the type of propeller which will best suit the need, and then to proceed to the design without loss of time in preliminary work.

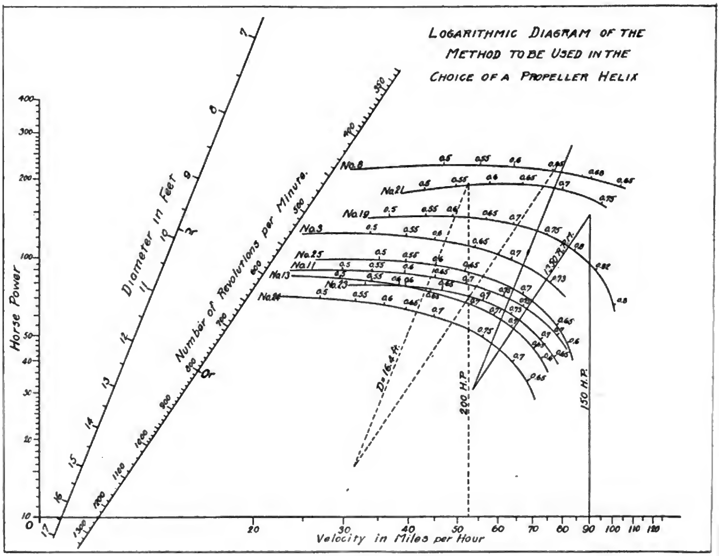

Fig. 1

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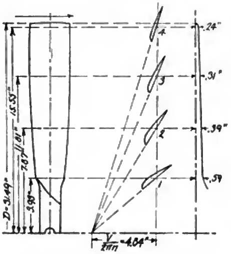

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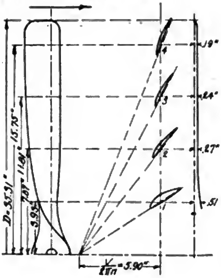

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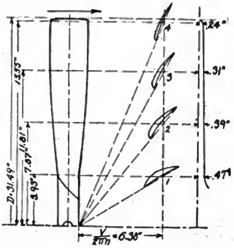

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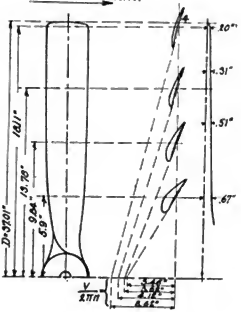
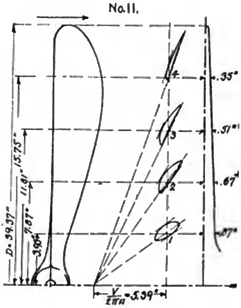


Propeller Charts Showing Characteristics of Various Propeller Shapes

No. 11.



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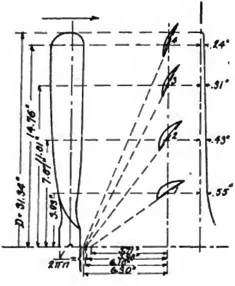

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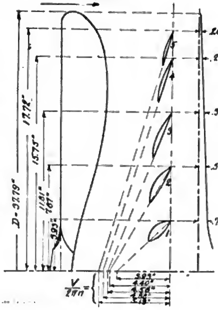
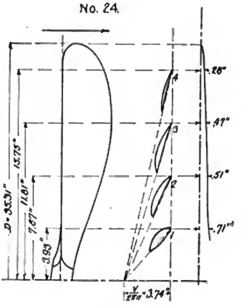


No. 24.



On the Value and Use of the Large Airplane

By F. Handley Page

The endeavor of the present article is to show how by the use of large airplanes America can make her weight felt in this war to a much greater extent than by equipment of any other sort.

It is a well known fact that the large airplane is an absolute necessity whenever great distances have to be traveled or large weights be carried. The high speed type of machine, with its very small margin of weight available for carrying useful loads, is of little value except for short distance fighting and high speed performance.

When great loads are to be carried or long distances be flown, one must resort to a somewhat slower machine, flying at about 100 miles per hour (instead of the 130 and more miles per hour which the speed scouts attain) and capable of carrying 20 lb. per h. p., compared with the 7 or 8 lb. of the high speed machine.

To fully understand the diverse problems which confront the employment of the military airplane it is necessary to examine the conditions prevailing at present on the Western Front. There great armies, immobilized by trench warfare, are separated from one another by very short distances, so that an hour or two's flight at the outside will display to the opposing side the whole of the enemy's defense works, depots, communication lines, and so forth. The carrying out of this reconnaissance work obviously entails considerable risk to the reconnoitering machine, and for the purpose of its protection it is essential that fighters of one type or another should accompany it. In addition to this, fighters go into action to keep away from the friendly lines enemy fighting and reconnaissance machines.

It is particularly worth attention that all these machines operate over relatively short distances only. The fighters, in particular, carry only light loads, so that their requirements are easily and amply met by the employment of small high speed scouts, which, owing to their great maneuvering ability, are able to fight at close quarters, and thus overcome the handicap of accurate gun fire, which is a conspicuous feature of present day aerial gunnery.

Such are then the requirements that must be met by an aerial force working in conjunction with an army engaged in trench warfare. In view of the very rapid development of the airplane, it is, however, quite possible that the whole present system of warfare may undergo, in the near future, extensive alterations. The advent of the large, multi-engined airplane appears in particular to forecast such a change; it seems, therefore, worth our while to examine in what way and to what extent the large airplane differs from the older small type of single-engined machine.

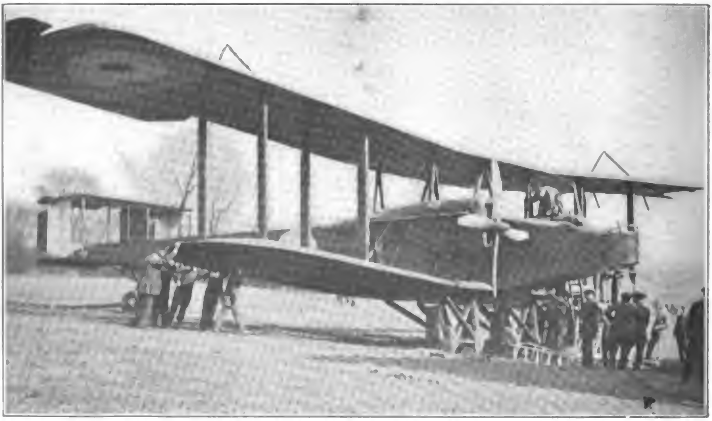
The first quality we notice is its ability to fly considerable distances with heavy loads, and whereas its large size affords more comfort to the crew, long distances may be covered without great strain upon the occupants.

There is, however, a further quality which any multi-engine machine possesses, namely, that of alighting when and where it chooses, thus minimizing the risk of a forced landing due to engine failure. If we could at the present time remove from the airplane's characteristics the feeling of uncertainty, we should at once advance its utility to a great extent. The multi-engine machine appears to well fulfill this requirement, for it is the engine that provides, more than anything else, at the present time, that element of uncertainty which makes a more extended use of the airplane problematical.

Since we are unable to build our engines very heavy, as in the case of locomotives and steamships, and so increase their reliability, we can but resort to a system of multi-engines to provide against breakdowns and so prevent the machine from landing on unsuitable ground.

The failure of one engine should not prevent the machine from flying home with the remainder of the power plant; to be sure, the speed would be reduced, but, on the other hand, with one engine cut out, more gasoline would become available, so that a correspondingly greater distance could be covered at reduced speed.

A further advantage may be found in the relative simplification of the landing chassis, whose present elaborate design is mainly made necessary by the eventuality of landing on unsuitable ground. A multi-engine machine being able to choose its landing ground, the cost of housing would

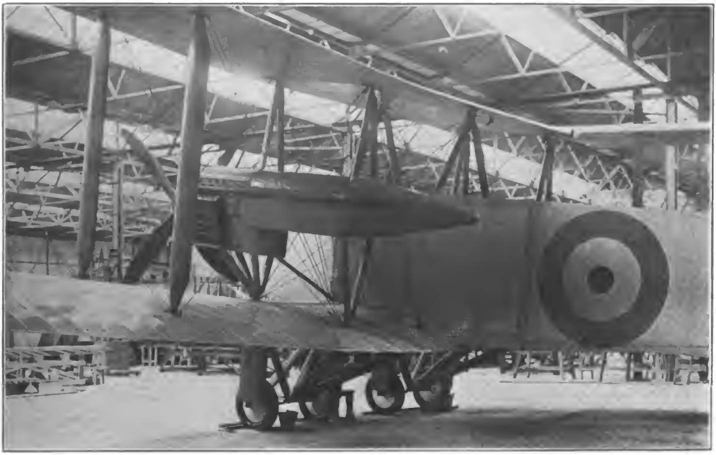


Three-Quarters Front View of the Handley Page Airplane

Official British Photograph

also be greatly reduced, because, instead of providing for a great number of landing places situated at short distances from one another, as has recently been suggested for commercial aviation, it would be quite sufficient to establish aerodromes only at such points where reasons of expediency required.

These considerations are also likely to alter current ideas in regard to the use of the seaplane. Seaplanes, whether of the boat or float type, have performances inferior to airplanes of the same size and power chiefly owing to the much greater weight and resistance of the boat or float as compared with the chassis of the airplane. If, however, we can discount the eventuality of a forced landing, we can just as well do away with the boat and float and employ ordinary airplanes for naval service, since the system of multi-engines insures the machine against being forced to alight on the sea.



Close View of One Engine and of the Chassis
Official British Photograph

A discussion of the large airplane naturally leads one to consider how this type of machine could be made particularly suitable to the needs of the United States in the present war. This problem may be dealt with under two headings:

1. Cooperation with the Allies on the Western Front.
2. Submarine patrol work.

The present requirements of the Western Front, as far as the cooperation of the aviation service with an entrenched army is concerned, have briefly been touched upon above. There opens, however, a far greater and wider sphere for the airplane if one proceeds to consider a real aerial offensive. While it is true that a number of bombing raids have been conducted in the past, these expeditions never extended over great distances, and the load of bombs that has been dropped on the enemy's interior lines has, relatively speaking, been a limited one.

With the use of large squadrons of multi-engine airplanes this situation would be materially altered. If one imagines a fleet of several hundred of such machines, each carrying one, two, or even three tons of bombs, penetrating after a flight of many hundred miles into the very heart of the enemy country and destroying with high explosives the manufactories which are essential to the provisioning of the people and the munitioning of the armies, it will be evident that we should be able to strike a blow at the very backbone of the enemy's armies.

No gun can, at the present time, fire the distance, or deliver so much explosive at a given spot as the airplane, and but few guns are able to produce the same effect over much shorter distances.

Such an offensive, which appears quite feasible in view of the present development of the airplane, could not hitherto be developed on the Western Front partly for the lack of adequate machines and partly for the pressing need of the armies for reconnaissance and fighting airplanes. It is obvious that until a sufficient number of such machines be made available it is useless to think of providing or attempting to provide airplanes for a great aerial offensive.

This is then a question that turns upon the productive capacity of the aircraft factories. Supposing the Allied output of airplanes could be enormously increased in the near future, then the immediate needs of the armies in the field could be more than met and the surplus of production be turned into supplying machines for an independent aerial offensive.

Such an eventuality may readily become an accomplished fact since America's entry in the war, for this country possesses all the requirements needed for the materialization of such an offensive. The well-known American ability for quantity production, as well as the large number of enthusiastic sportsmen that is to be found in the United States, would undoubtedly make an ideal combination for realizing a great bombing campaign against Germany. Such an offensive could be carried out by a large fleet of American airplanes operating as a separate unit, since its work would be separate, too, from the immediate needs of the armies in the field.

I shall endeavor to describe how such an airplane offensive could be carried out and what actions there may take place. To begin with, it is essential that it be carried out by night, for, given adequate instruments, a place can be reached by night just as surely as in daytime, while on the other hand there is less likelihood of losing machines by anti-aircraft fire or hostile airplanes.

At the base a hundred of these large machines are wheeled out in the darkness of the sheds; the engines are started up and the crews go on board. The latter are small in numbers compared to those required for handling a Zeppelin airship carrying an equal load of bombs, and small is the number of assistants required to launch the machines.

The wing tips and the tail of each airplane are illuminated with small lights, so that each pilot can see the other's machine and avoid collision. The navigating instruments are also lighted electrically, and by the aid of these the pilot is able to steer the airplane to its destination.

Fully equipped with their quota of bombs, they fly on their course to their destination until the leader in charge of the squadron gives the signal that the goal is reached; each machine then aims on the target that has been set for it and releases its bombs. Immediately with the dropping of the bombs, or perhaps before, owing to the noise of the engines, the attackers are met by a defense squadron of airplanes and also by anti-aircraft fire from the ground directed by searchlights.

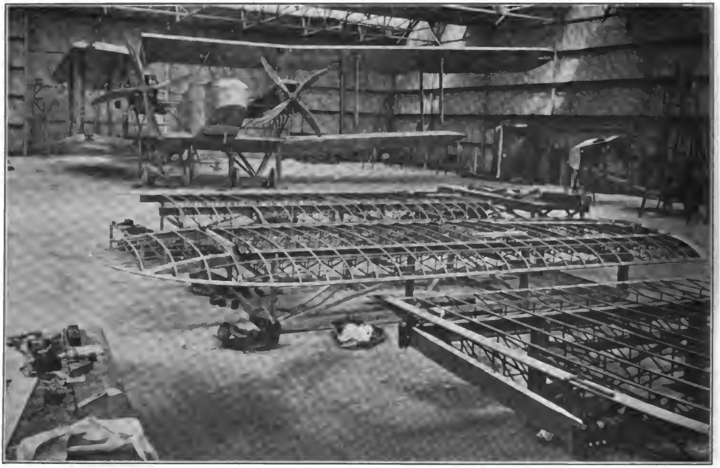
Several of the big machines carry heavy guns, and these immediately go into action on the searchlight controlled batteries. With well-aimed fire, these searchlights are put out of action and darkness reigns once more. The flares which have been dropped in order to illuminate the ground and enable the target to be seen when dropping the bombs have gone out.

In the prevailing darkness it is almost impossible for the defender squadron to find the attacking force, which is now making for home. Lightened of their load of bombs, they are able to outfly the defenders, and their ability to climb more than outweighs the pursuit machines' extra speed and endows them with sufficient maneuvering ability to beat off hostile attacks.

The day is dawning when the bombing squadrons return to their sheds, with the report that some munition factory, steel works, or power station, has been completely wiped out, and that, for some time at least, that center of hostile industry has been demobilized, and so much less will be available for the hostile armies.

Incidentally one might remark that it is easier to land a large airplane in the dark than a small one, for large machines pull up quicker on the ground, and, owing to the cushioning effect of the big planes on the air between them and the ground, the alighting speed is smaller than in the case of the small airplanes.

For bombing work, the large airplane is the ideal machine. It is essential, when bombing, that the platform should be steady, and that the man in charge of the bomb dropping should have plenty of comfort, so that he may drop his bombs with some accuracy. A large machine affords a splendid platform on which to lie, excellent sighting opportunities, and great all-round steadiness. It follows, therefore, that bombing can be conducted from a large airplane with far greater accuracy than from a small machine where the pilot or passengers have to contend with lack of space and an unsteady platform.



Wing Skeletons Showing Metallic Lattice Girder Ribs

Official British Photograph

Let us now turn to the question of effective fighting of submarines. The great point in favor of an airship for naval patrol is that it is able to remain floating in the air with the power shut off, the men in the car are comparatively comfortable, and thus an excellent observation station is obtained for observing any hostile ships and sending back a wireless message to the base.

Exactly the same advantages, except in point of hovering, are obtained with the large airplane. Owing to the excellent possibilities of observation, a much closer watch can be kept over an exceedingly large area, and much better observation can be obtained than with the ordinary small seaplane engaged in the same work.

Owing to the large size of the airplane, a one, two, or even three-pounder gun as well as many bombs can be carried, and if it is not possible to reach the hostile ship or submarine before it submerges, the gun may be used with effect where the bomb could not be dropped, owing to the distance of the target. Better bomb-sighting and more effective gunfire may thus be obtained than in the case of the small airplane, where only machine guns, firing rifle ammunition, can be mounted and the load of bombs is necessarily limited.

A fleet of such multi-engine airplanes could continuously patrol 300 to 400 miles out to sea and effectively protect in daytime the shipping lanes by escorting incoming and outgoing vessels, and thus reduce to a large extent the submarine's ability to destroy commerce.

Another interesting feature of large airplanes is their greater economy from the point of view of production and operation in proportion to a number of small machines possessing equal carrying capacity and speed.

A large airplane of, say, 600 h. p. can carry a weight of 20 lb. per horsepower, or 12,000 lb. of total weight, half of which is effective load, so that we get a useful load of 10 lb. per horsepower, or 6000 lb. total.

Supposing, now, we had these loads separately carried by a number of small machines of, say, 200 h. p., flying at a speed of 130 m.p.h. Such machines would be able to carry about 8 to 9 lb. per horsepower, of which only 1½ lb. per horsepower could be reckoned as useful load. For every one of these machines, therefore, we should have 1½ times 200 of 300 lb. of useful load.

Forward Joint of the Folding Wings
Official British Photograph

For a total weight of 6000 lb. to be carried, this would require no less than twenty machines. But as the total horsepower of these twenty machines would be twenty times 200, or 4000, against 600 h. p. required for the large airplane, it follows that the operation of the latter will be about six times more economical than a corresponding number of small machines. A small number of large machines, therefore, makes a much smaller demand on the resources of a country than a large number of small machines, for it reduces the engine power, fuel supply and number of crews required and, consequently, the cost of operation.

It remains now to speculate as to the aspect of warfare in the distant future when the extended use of large airplanes, combined with new methods of land attack, will have revolutionized the art of war.

For obtaining accurate gunfire, the gun must be mounted on a specially made emplacement and have attached to it a suitable airplane for spotting at long distance the effect of its shells. This airplane must be equipped with radio for reporting the effect of the shells and be protected by fighting machines to beat off any enemy airplanes.

One can imagine all this system changing in the wars of the future. Instead of an artillery bombardment preceding the attack of the infantry from the trenches, and covering the infantry as they advance with a curtain of fire, the "preparatory fire" will be effected by airplanes carrying large numbers of heavy shells.

One imagines the attacking army equipped with large numbers of bombing airplanes which, rising up into the sky and remaining there at a height of 15,000 or 20,000 feet, will rain down on the defending army a hail of shells, sweeping away the barbed wire and entrenchments just as the ordinary artillery bombardment now does.

A continuous stream of large airplanes will be flying back and forth to fetch new loads of bombs to be dropped on the enemy. In front of them will sweep a cloud of small fighting airplanes that will drive off the attackers which may endeavor to get at the bombing airplanes.

Below, instead of infantry charging the lines, masses of land battleships carrying infantry within their armored walls will move forward as the way is cleared by the aerial bombardment.

At once we have a change from the present stagnant form of warfare: the trench is done away with, and the infantry, while maintaining its effective covering, has regained its mobility.

Play is thus again possible for the strategic and tactical abilities of the opposing generals, and warfare will, once more, become one of mobile operations, thus making possible prompt decisions.

The Handley Page Battle Airplane

A machine of the type herewith described having accidentally landed within German lines, the following dimensional and performance data obtained during trials carried out by an admiralty staff under Commander Sedden, R. N., may now be published:

Characteristics and Trial Performances

Span, 100 ft.
Area, 1,700 sq. ft.
Gross weight fully loaded, 11,500 lb.
Gross weight normally loaded, 10,500 lb.
Weight, machine bare (including armor), 6,500 lb.
H. p., 540 (two-270 h. p. Rolls-Royce engines).
Area loading, normal 3¼ lb. per sq. ft.; maximum 6¾ lb.
Speed loaded, normally 90 m.p.h. Approximately, 40 m.p.h. low.
Climb, 10,000 ft. in 30 min. approximately.
Fuel capacity gasoline, 400 B. I. gal. (equals 2,900 lb.).
Engine consumption, full power: 325 lb. per hr.
Endurance at full power: 9 hrs.
Endurance slightly throttled: 11 hrs.
Particulars of load:

Gasoline	2,900 lb.
Oil	250 lb.
Crew, 3 men	540 lb.
Gun mountings and bomb gear	310 lb.
Total	4,000 lb.

To carry bombs either fuel could be reduced or the load could be increased by 1,000 pounds, as done in trials, or both. The designed bomb capacity is sixteen 65 lb., or 100 lb., or 112 lb. high explosive bombs (all of which fit the same gear). On a later design provision is made for carrying eight 250 lb. bombs. The maximum load of bombs which could be carried is therefore 2,000 lb.; with three machine guns and ammunition the maximum armament load is therefore about 2,180 lb., which corresponds to 5½ hours full power fuel with the machine loaded to maximum.

If the armor is done away with entirely, the weight light is reduced to 6,000 pounds approximately, allowing either for engines of greater power or for an additional 500 lb. of useful load.

LATER IMPROVEMENTS

After the Admiralty trials, various improvements were made on the machine. These consisted of the following:

1. Suppression of armor as indicated above.
2. Reduction of head resistance of engine nacelles and radiators, as a result of which a speed of 95 m.p.h. was attained with the Rolls-Royce engines.
3. Increase of horsepower by the installation of two 350 hp. Sunbeam engines. This power plant has a lower fuel consumption than the one first installed, for it only burns 335 lb. of gasoline per hour at 680 h. p. gross. Consequently the endurance remains practically unaltered, while the speed at altitude as well as the climb is greatly increased. With the Sunbeam installation, the maximum speed at 10,000 ft. altitude is about 94 m.p.h.

A noteworthy feature of the machine is that it has never been fitted with any servo-motor control gear; this has been found quite unnecessary, chiefly owing to the large amount of inherent stability embodied in the design.

WAR USES

Actual warfare experience has proved that where military objectives are well protected by anti-aircraft guns, attacks by aircraft should be made at night. Owing to chances of collision it is, therefore axiomatic that machines for night bombing must be as large as possible so as to reduce numbers. "Pusher view," that is, a wide arc of vision is also essential for accurate bombing, especially by night. The Handley Page seems therefore *par excellence* the type for strongly defended objectives. The use of large airplanes by day would scarcely be permissible over areas strongly defended with anti-aircraft guns, as good results are obtained with guns up to 14,000 ft. It is however quite legitimate to utilize this type for day bombing of objectives not strongly defended (or well practiced) that is, Essen and all towns in Germany behind the Rhine, provided these machines are exceptionally heavily armed against aircraft attack.

To be properly armed in this sense, at least three twin machine guns would have to be carried and probably four twin machine guns, which would require a total crew of six men. Examination of weights and loads indicated will show that no difficulty would be experienced in carrying such armament into effect. It should be noted also that the general policy is to accompany bombing machines with gun machines if possible, making the latter of same type as the former.

NOTABLE PERFORMANCES

Among the most notable performances of the Handley Page twin-tractor biplane may be mentioned (1) an altitude flight of 7,180 ft. with twenty-two men aboard; (2) an altitude flight of 13,000 ft. with full load, 10,000 ft. being reached in 25 minutes (this flight was made with a Sunbeam engined model); (3) a flight from London to Paris in 2 hours 10 minutes (train and boat time, in peace, 7 hours 35 minutes); (4) a flight from London to Rome with a crew of five in 7 hours total flying time.

Side View of Body With Right Cellule Folded Back

Official British Photograph

Disturbing Bodies on Wing Surfaces

By Alexander Klemin

On many recent examples of airplane construction, we find disturbing bodies such as radiators and fuel tanks below and above the wings. It becomes important to determine where such obstructions shall be placed from an aerodynamical point of view, so that they will least affect the lift of a wing and impose least head resistance on a machine. Experiments to determine these points were carried out at the Massachusetts Institute of Technology.

An R. A. F. 6 wing section was employed of chord 3 in. and span 18 in., with an obstruction of dimensions 2 x 3/8 x 3/8 in., the tests being conducted at a wind speed of 30 m.p.h. If we imagine the wing to be 1/16 full size, the dimensions of the obstruction would be 4 ft. x 9 in. x 9 in. with a projected area to the wind of 3 ft., which would be roughly comparable with the dimensions of a honeycomb radiator. The tests were carried out with the center of the block placed at 1/5 of the chord from the leading and trailing edges, on the upper and lower surfaces at the center section of the wing.

As experiments at the National Physical Laboratory have shown, it is the center section of a wing which develops the greatest lift and efficiency, both lift and *L/D* falling off progressively towards the tip. If we consider also a typical pressure diagram as shown in the figure, the possibility of important losses becomes apparent. Since we are concerned with qualitative results only, the actual lifts and drifts on the model have been plotted in the curves. The lift in position *A* is considerably less throughout the working range of angles than in any other arrangement.

If we consider that the block is then placed at that point on the wing where the maximum suction pressure is developed, we can see that this loss in lift is to be reasonably expected. In other positions the loss in lift is not appreciable, and when as at *C* the block is placed on the lower side toward the rear trailing edge, the lift is actually increased; the obstruction apparently increases the pressure on the lower face, of course at the expense of some additional drift.

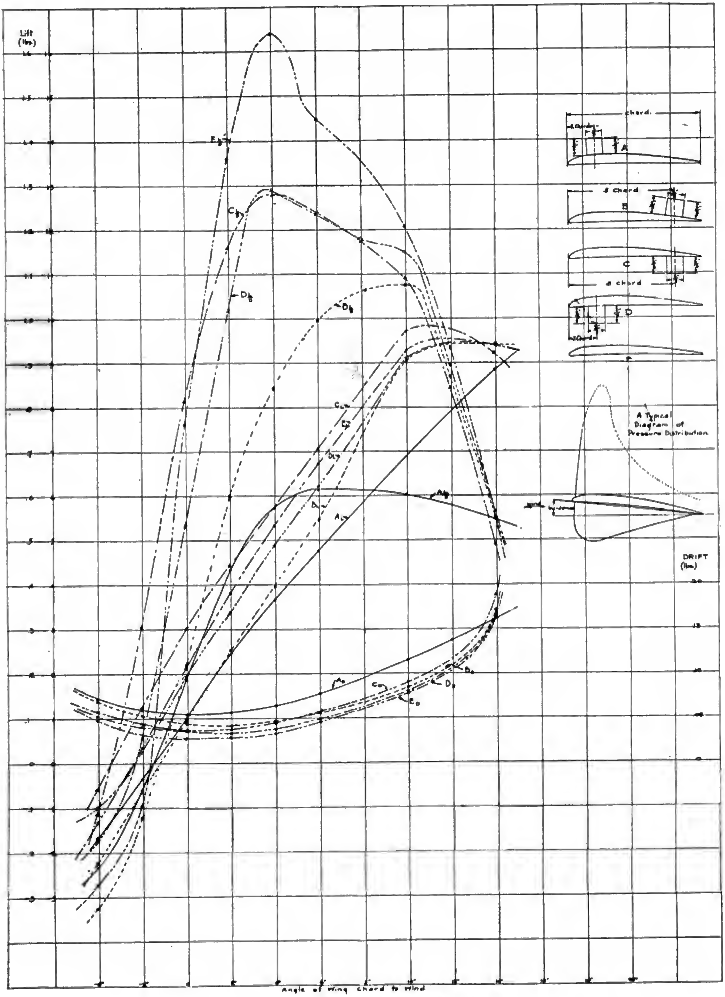
The drag and *L/D* are poor for the combination *A* and *B* on the upper surface of the wing. *D* and *C* have smaller values of *L/D* than the wing alone, but then the obstruction is a real one, which would produce drift wherever it was placed on the machine.

It is also noteworthy that the increase in drag of the combination *C* over the wing alone is so small. If the block were treated as a flat plate normal to the wind, with a coefficient $K = .0028$ in lb. ft./sec. units, its resistance would amount to .0282 lb.

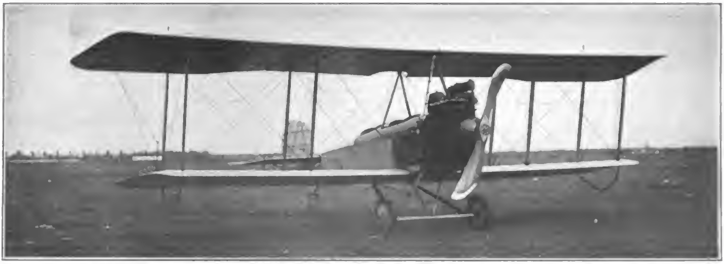
At 0 deg. the drift of the wing alone is .0280 lb., that of combination *A* is .0540, or a difference of .0260 practically equivalent to the flat plate figure.

At the same angle the difference between the drag .0370 of combination *C* and the .0280 of the wing alone is only .0090. Something like 60 per cent decrease in drag is therefore gained at small angles by placing the block at *C* as compared with the drag of the block placed either at *A* or anywhere else on the machine where it would not be sheltered by the wing. At bigger angles this gain would also maintain a high percentage.

It would seem advantageous, therefore, to place an obstruction of this nature on the lower surface of the wing towards the trailing edge rather than anywhere else on the wing.



DISTURBING BODIES ON WING SURFACES



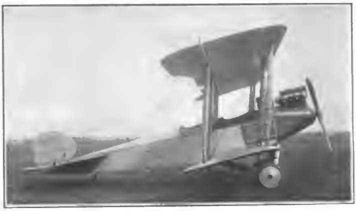
Press Illustrating Service *Passed by Committee on Public Information*

The Aeromarine Land Training Airplane

The land training airplane which the Aeromarine Plane and Motor Co., of Keyport, N. J., has recently produced to Army Specifications No. 1001 is a two-seated tractor biplane of conventional design. The power plant consists of a model A-7a Hall-Scott engine developing from 90 to 100 horsepower. The span of the upper wings is 37 ft. and that of the lower is 34 ft.; the wing area is 420 sq. ft. A minimum safety factor of seven and one-half is maintained throughout the machine, with greater allowance on vital parts.

According to the manufacturers' specifications the following are the machine's most noteworthy features:

Body Construction—This machine is designed especially for training purposes, and special attention has been given to the body design with a view of allowing for replacement of parts such as longerons, etc., with the least possible amount of work.



SIDE VIEW

Press Ill. Service *Passed by Committee on Public Information*

The longerons are of large section, lightened with a view of obtaining the best strength and least weight. Liberal consideration has been made for the rough usage to which the bodies of school machines are subjected, and all wires, turnbuckles and fittings are sufficiently strong to withstand this work.

The streamline cover on top side of body is quickly detachable, while the cloth cover on the sides and bottom is laced on to allow immediate access to the interior without destroying the coverings.

Both cockpits are arranged with full complement of instruments and gages on instrument board.

Chassis—A special chassis has been designed for use on this machine, with a view of allowing for usual field repairs necessary on all training equipment.

The construction of the shock absorber holding device is such as to allow for its complete replacement on the field without the necessity of factory repairs, and the parts, so far as possible, have been made interchangeable from left to right, and vice versa.

The axles are 1½ in. diameter and 3/16 in. wall in the hubs and 1¾ in. between wheels.

The hubs are equipped with bronze bushings which eliminates any possibility of the wheels seizing.

Wings—The R.A.F. 6 wing section is used. The arrangement of the wings is such as to give the greatest possible inherent stability without sacrificing conditions of carrying capacity.

Struts—The struts have been designed upon the data gathered from a series of tests of full sized members. They are dovetailed, jointed and wrapped with five bands of linen thread.

Turnbuckles—Designed after R.A.F. specifications.

Wire Fastenings—Cone socket wire terminals are employed, as this is the only fastening that allows the development of the full capacity of the wires. Contrary to common belief, extra skill is not necessary to make a secure job with this fastening, in fact, it is less necessary than with other types now in use.

Cloth—The fabric used is the best raw Irish linen weighing approximately four ounces, and having approximately the same strength in both the warp and the weft. The cloth is placed diagonally on the machine and the seams are lapped and double sewed. The cloth is sewed to the ribs, and such seams are covered with linen tape to protect them from the weather. From three to five coats of lacquer are applied, and the wings are varnished or not, at the option of the purchaser.

Fuel Supply—Four hours' fuel is carried. The fuel tanks are constructed of the best tank tin with lapped and riveted seams, and are fitted with baffled plates riveted and soldered in. Suitable gauges are supplied showing amount of fuel at all times.

Drain cocks to the exterior of the body are supplied. Special care and attention is given to the installation of pipes and fittings to avoid leakage due to vibration, etc.

Stabilizer—The stabilizer is of the double cambered type and is mounted in two pieces on either side of the body. These pieces, together with the elevators, are quickly detachable from the body.

Rudder—The rudder frame is of steel tubing and is mounted in the conventional way.

Mufflers—Exhaust gases are piped away from the motor and discharged beneath the planes, thereby adding greatly to the comfort of the occupants without any appreciable loss of power.

Aeromarine Making Additions

The Aeromarine Plane and Motor Co. is making extensive additions to its plant at Keyport, N. J. When completed, the additions and the separate structures under way will approximately double the present capacity of the plant. Three sections joining the north wing will add 30,000 square feet of working space, while separate buildings will house the Layman engine department.

The Controlled Saturated Atmosphere Expansion Method of Lumber Drying

By Thomas D. Perry
of the Grand Rapids Veneer Works

There are four reasons why green lumber is unsuitable for any manufacturing purpose.

1. It is too pliable, lacking stiffness and strength.
2. It will shrink as it dries and destroy any glued or fitted joints.
3. It is exceedingly heavy and weighs too much for economical handling and transportation.
4. No tools or machines will work well or smoothly on heavy wet lumber.

Green softwood lumber (evergreens, more properly called conifers) contains nearly as much water, sap, acid, oil, gum, etc., as it does fiber. This is measured on a weight basis, rather than a volume comparison. In the case of hardwoods or flat-leaved trees, the moisture elements are about one-third of the weight of the green lumber, and the fiber comprises the other two-thirds.

Moisture in the tree exists in two forms: free moisture, which is practically water; and cell moisture or the real sap, which contains acids, gums, oils, pigments, etc. The former is the moisture in excess of approximately 30 per cent (based on dry fiber weight), and the latter remains after the free moisture has been evaporated. Little shrinkage takes place until the removal of the cell moisture begins.

Free moisture is easily removed by air drying, in a comparatively short time, from thirty days in 1-in. pine to ninety days in 1-in. oak, providing atmospheric conditions are reasonable. Artificial means, or excessively long air drying (from two to four years) are necessary to remove the cell moisture sufficiently for manufacturing purposes, down to a basis of 5 to 10 per cent moisture content.

If an instrument maker of the "old school" wanted to do a particularly fine bit of lumber drying for a violin or flute, he put his boards in a kettle of water and boiled them. The boiling process dissolved and diluted the sap and acids and rendered their evaporation relatively easy. A short subsequent air drying reduced the boards to a sufficiently dry condition.

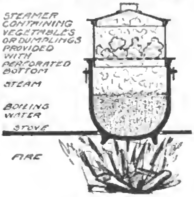

STEAMER CONTAINING VEGETABLES OR DUMPLINGS PROVIDED WITH PERFORATED BOTTOM
STEAM
BOILING WATER
STOVE
FIRE

Fig. 1

Attempts have been made to similarly dry lumber in tanks or retorts, but they all proved costly to install and expensive to operate. High pressure steam was used, and many kilns of lumber were damaged by being heated too rapidly or too hot. As a practical piece of lumber drying equipment they have been abandoned, but are still used for the sterilization of certain fungus growths in lumber, and the diffusion of pigment or color.

The method of preparing a "New England boiled dinner" was found to contain a principle that was applicable to efficient lumber drying. There is little, if any, difference between boiled potatoes, in water, and stewed or steamed potatoes in the double kettle used for the New England boiled dinner illustrated in Fig. 1.

The double kettle suggested that, if lumber could be cooked or stewed with low pressure or exhaust steam, the saps and acids would be dissolved and diluted as thoroughly as in the instrument makers' boiling process.

Experiments proved that such was the case, and demonstrated further that lumber, when subjected to a low pressure steam spray in a room with a temperature of from 125 to 150 deg. Fahr., was prepared for drying fully as well as at a temperature of 212 deg. Fahr., and with much less danger of damaging the lumber.

The practical lumber cooker evolved into a form of building and equipment shown in Fig. 2.

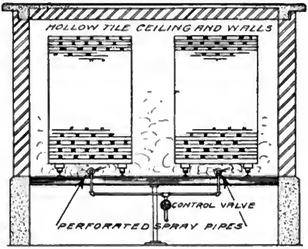


Fig. 2

The lumber was piled on trucks with stickers to allow access to the surface of every board. It was easy to get a saturated atmosphere (100 per cent humidity) in such a room and to keep the temperature down to a safe point of approximately 130 deg. Fahr. Two or three pounds steam pressure (above atmosphere) was found enough to secure the humidity without excessive heat.

The size, quantity, and length of the spray pipe, the number and size of perforations, and the time of steaming are varied with different kinds, thicknesses, and ages of lumber. Green and partially air dried lumber can be treated with equal effectiveness.

The natural question then arose as to whether it was necessary to complete the drying in the air. A little experimentation showed, that by gradually reducing the humidity and increasing the temperature, the lumber could be completely dried in the above steam room, in a very few days. This required heating pipes in addition to the spray, and also adequate ventilation flues. The form of kiln eventually developed is shown in Fig. 3.

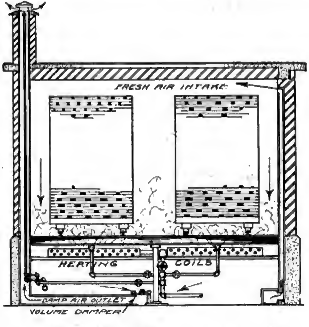


Fig. 3

It will be readily recognized that the ventilation must be proportioned and arranged to carry out heavy wet air. The circulation is therefore downward, and a damp air accumulation pit is provided below the coils. From this pit is a series of horizontal ducts terminating in vertical stacks, each stack being provided with heating pipes to accelerate the flow of damp heavy air upward.

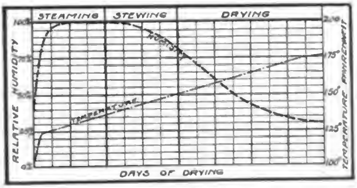


Fig. 4

The cycle of steaming, stewing (cooking) and drying is given on the chart shown in Fig. 4, although the gradations from step to step are gradual and not abrupt. The sap "loosening" (dilution and dissolving) effect of the high humidity is exceedingly important, and all changes in temperature and humidity should be gradual and never sudden.

This drying method, which was originally developed for effective and speedy drying, possesses two other important features, that are worth more than passing notice.

The old fashioned method of drying, which was an application of direct heat only, with a very low humidity, either through steam coils, blowers, or both, had a tendency to overdry the surface of the lumber and underdry the center or interior of the board, making an end cross-section look something like that shown in Fig. 5.

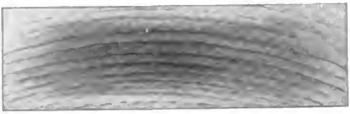


Fig. 5

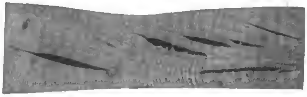


Fig. 6

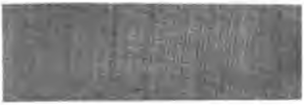


Fig. 7

Showing End Section Quarter Sawed Board, Indicating Above How Lumber May Be "Hollow-Horned" and "Honeycombed" by Internal Strain, and Below How Lumber Can Be Dried Without Internal Strain

The depth of color indicating the degree of wetness, a surface moisture content of 2 per cent and a center moisture content of 10 per cent are not unusual, making an average of 6 per cent moisture content.

In the vapor type of kiln, all boards will be evenly dried from surface to center, because the surface is kept wet by the high humidity, while the center moisture is coming out. If the boards, when placed in the vapor kiln are partially air dried, and have a surface drier than the interior, the preliminary steaming will tend to equalize the moisture in different boards.

The uniform condition of wetness or dryness in boards, characteristic of the vapor kiln at all stages of drying, prevents internal strains, and the consequent injury to lumber by fiber stress indicated by warp, wind, and hollow horn, and the damage that comes from fiber cleavage or separation, such as checking and honeycombing.

Another characteristic of vapor drying which is of great value is the plumpness of the lumber. Baking lumber dry by heat only shrinks it unduly, while stewing it dry retains most of its thickness. The baked potato is always shrunken and the boiled or stewed potato is always plump. It is not, of course, possible to dry lumber without any shrinkage, as the withdrawal of so much moisture will inevitably mean some loss of dimension.

The vapor process will, however, reduce the shrinkage to a minimum, in any case far below the baking process.

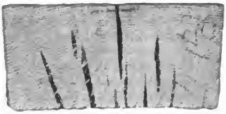


Fig. 8

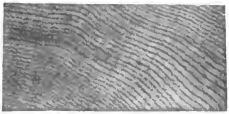


Fig. 9

Showing End Section of Plain Sawed Lumber, Indicating How it May Be "Hollow-Horned" and "Honeycombed" and How it Can Be Dried Without Internal Strain

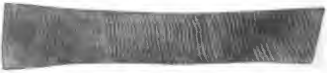


Fig. 10.

Showing "Hollow-Horning" Due to Internal Strain in Uneven Drying

[Author's Note.—This article is a description of the evolution of one type of drying apparatus, of which some 1,800 installations have been made. The steps in the evolution indicate the necessary provisions to preserve the strength and quality of the lumber, and yet dry it by a method that is commercially economical and feasible. The United States and foreign patents on the type of kiln described are owned by the Grand Rapids Veneer Works, Grand Rapids, Michigan.]

The Controlled Unsaturated Atmosphere Expansion Method of Lumber Drying

By A. J. Henry
of the Cutler Dry Kiln Co.

The conditioning or seasoning of woods, such as spruce, ash, oak, mahogany and pine, that go into aeronautical construction, is a comparatively new problem in lumber drying.

Properly seasoned spruce, the most important lumber used, can no longer be obtained in sufficient quantities of the required grade. Therefore, in order to meet the demands of present day production, green lumber must be seasoned artificially, which, if properly done, produces a better dried stock than can possibly result from natural air drying.

The methods commonly used for kiln drying lumber are not suitable for airplane spruce. Lumber used in the manufacture of furniture, etc., must be "bone dry." Nearly all the moisture and a big percentage of the sap are taken out, as the element of strength is not a large consideration. For example, the writing bed of an office desk is at times 2 in. in thickness. A bed ½ in. thick would give sufficient strength for any use, but the heavy, massive 2-in. bed is used as a matter of appearance and design.

In the case of airplane spruce, strength with lightness is the first consideration. The part must *not* be what is known as "bone dry," yet the moisture must be evaporated while the sap or life of the wood is retained. The United States, as well as the Allied Governments, realize this, and their requirements and tests are very rigid.

There can be no haphazard hand control of temperature, humidity and circulation. The specified conditions must be maintained evenly and continuously throughout the seasonning process.

The Front View

These requirements of a comparatively low temperature, in order to preserve the sap, make it practically impossible for the ordinary type of lumber kiln, to obtain the high humidity within a reasonable length of time.

In the Cutler kiln the side walls and roof are made of a special fabric, the weave of which is of the correct porosity to retain heat, and at the same time allow proper ventilation. The side walls are arranged to raise and lower so that the loading and unloading can be done conveniently from any side desired. They also assist, in a very important manner, in distributing the circulation evenly over all parts of the kiln.

Inside the kiln are placed specially constructed heating coils which are operated by low pressure steam and the temperature is automatically controlled to any given degree.

The humidity adjusting apparatus is arranged to work in connection with the heating coils. In the same space, also working with the heating coils, are placed small motor fans which increase the circulation and keep an even humidity and temperature throughout the kiln. By these means the conditioned air moves through the lumber piles in lines parallel to the kiln floor.

It has been proved by practical experiments, that spruce can be best seasoned by expansion of its moisture, rather than by its absorption from the surface, by dry hot air. The expansion method puts no strain on the surface, and the piece dries through evenly, if the conditions are right for this kind of seasoning.

By using a rapid circulation of heated air of a high relative humidity, the slightest excess of moisture over that of the air, thrown off by the act of heating the lumber, is carried away without reducing to a dangerous degree the moisture contents of the surface. A continuous drying of this sort produces better lumber because the sap has not been affected, except to remove the moisture down to the desired point.

This action is directly opposed to the method of opening the surface pores with heat and moisture, and then decreasing the humidity, thus having the air act as a blotter, absorbing the surface moisture, and that moisture near the surface. The "blotter method" tends to keep the surface always drier than the center of the lumber, and as the lumber approaches the required dryness, there is always an uneven distribution of the remaining moisture. This is not so serious a defect in 1 in. lumber, but in 2 in., 3 in. and up to 6 in. stock the difference is very great, and the drying must be done very slowly.

With Side Walls Raised

Showing Side Walls

In heavy stock, such as airplane beams, the difficulty is increased by the thickness. The extreme non-conductivity of heat of fairly dry lumber makes it necessary actually to prevent surface drying until the piece has been heated through. We prefer to use "dead green" lumber as the moisture acts as a conductor, and the piece heats up more evenly, and the drying is quite as quick as would be the case with partially seasoned lumber.

Spruce beam stock 3 x 6 in. cross section can be seasoned from 48 per cent moisture content down to 10 to 12 per cent in twelve days, without lessening its strength appreciably more than is done by natural air seasoning.

Airship Suspension Systems*

By "Effingham"

The chief points to be borne in mind in designing the suspension system of an airship are:

(1) The distribution of the weight over as wide an area of the envelope as possible;

(2) The reduction of head resistance;

(3) The reduction of overall height or head room;

and it is interesting to examine the various efforts which have been made to meet these requirements.

External Rigging Systems

In a spherical balloon the basket is slung from a net covering the top half of the balloon, and this method was adopted for slinging the car of most of the earlier types of airship from the Meusnier onwards. As, however, in a non-rigid or semi-rigid airship, with which types alone we are concerned at the moment, all the stresses have to be met by the pressure of the gas and the strength of the fabric, this method has the disadvantage of putting the top surface of the envelope in compression, though it was many years before this fact was fully appreciated.

A modification of this system was, indeed, adopted in the first British airship, the "Nulli Secundus," which was provided with broad bands of fabric carried over the top surface of the envelope, the car being slung from the extremities of these bands which terminated at about the "equator"—to employ a ballooning term—on a level with the longitudinal axis of the airship. In the majority of modern airships, therefore, the point of suspension will be found to be at or below the longitudinal axis when the rigging is external, though this is not the case usually in the various internally-rigged types.

"RIGGING BAND" SUSPENSION

The most usual method, nowadays, is the employment of a "rigging band," which consists of a strip of fabric—generally two or three-ply—sewn and stuck around the envelope either at the circumference or near the bottom surface. The latter method has the advantage of reducing the size of the rigging band and so saving weight.

Who was the first to introduce this method the present writer is unable to say with exactitude, as illustrations of early airships are in the majority of cases so indistinct and details so vague that it is difficult to say with certainty whether the rigging band is actually stuck to the envelope or whether it is merely the termination of a net or fabric covering over the top half of the envelope. It was, at any rate, used in the early Parseval ships, and also in most of the French Lebaudy, Astra, and Clément-Bayard types. More definite information on this point would be interesting. The "Nulli Secundus" in its later form had a rigging band, while retaining the fabric or webbing bands for the handling guys.

THE PARSEVAL SYSTEM

In 1912 (British Patent No. 4915), the German Parseval Airship Co. (Luft-Fahrzeug-Gesellschaft) of Bitterfield invented a system of "trajectory bands" in conjunction with a rigging band, which has been embodied in all their airships built subsequently. This consists in carrying fabric bands transversely around the envelope from the rigging band on each side, along the lines of maximum stress, instead of circumferentially around the envelope as in the older superficially similar method. (Fig. 1).

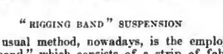


FIG. 1

Santos-Dumont in his airships usually employed a bamboo fastened longitudinally to the airships, from which the car was suspended.

THE CROW'S-FOOT METHOD

The only other system of external rigging which has been adopted of recent years is that of dispensing with the rigging band and attaching the rigging guys direct to the envelope by means of crows'-feet. This is obviously only applicable to airships of very small size, as it involves a considerable local strain on small portions of the total surface of the envelope.

Types of Cars

Up to the present we have only dealt with the method of distributing the ultimate strain of the weight of the car over the surface of the envelope as far as the attachment to the envelope is concerned, and it is next proposed to deal with what may be described as the other end of the problem—the size of the car, and the resulting angles of the rigging guys.

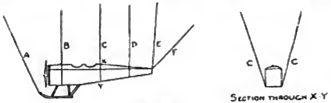


FIG. 2

It will be readily appreciated that the longer the car the more easily can the weight be distributed and the more vertical the rigging guys will be, and a few moments' reflection will show that a long car also admits of closer rigging to the envelope, because, if a short car be employed close to the envelope, it is impossible to carry the guys to the more distant points of the envelope, except at a prohibitive angle.

A long car, however, involves increased head resistance, increased weight—which is augmented by the fact that the car must be of greater proportionate strength to resist the increased stresses produced by the length—and waste of space.

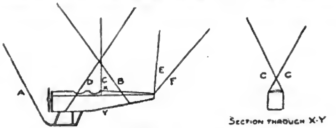


FIG. 3

This difficulty is got over in the semi-rigid school by employing a rigid girder-keel close under the envelope or—in the case of the "Veeh" and some other types—attached to and following the curvature of the envelope, from which the car is suspended instead of direct from the envelope itself.

This is a compromise which is now practically obsolete, though it still exists in a somewhat specialized form in the case of the majority of Italian airships, which will be dealt with later.

The semi-rigid system has always seemed to the writer a somewhat ignoble begging of the question, as it involves most of the disadvantages of the long car non-rigid system without providing any real solution of the problem.

The excessively long girder car is now also gradually falling into desuetude, and most externally rigged non-rigid airships now have quite a short car suspended from a rigging band, with the addition of trajectory bands in the case of Parseval airships.

THE UNITED STATES S. S. TYPE

The United States S. S. type airships adopt the rigging band, but have what appeared to be a defect in the actual arrangement of the guys. There are five rigging guys on each side of the car, and of these all, except those at the bow and stern, are dropped perpendicularly from the envelope (Fig. 2). This leaves the forward guy to bear practically the whole weight of the car when the ship is climbing, which could easily be remedied by crossing guys *B* and *D* as in Fig. 3. Similarly, the center guys (*C*) should be crossed transversely, as seen in end elevation, to prevent the tendency of the car to roll. The importance of both these points is emphasized in a patent (No. 15,872) taken out by C. Maiche in 1912.

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* From *Aeronautics*, London.

Internal Rigging Systems

THE TORRÉS-QUEVÉDO TYPE

External rigging has the disadvantage of enormously increasing head resistance, and several attempts have been made to devise a satisfactory system of car suspension in which the suspensions are for the greater part inside the envelope. The best known of these is that invented by M. Torrés-Quevédo, a Spanish engineer, in 1907 (British Patent No. 15,938), and exploited commercially by the French Astra Co., the British rights being vested in Messrs. Airships, Ltd.

In this system an envelope of trefoil shape in cross-section is used, formed by inscribing a semi-circle on each side of an equilateral triangle, the semi-circles forming the envelope, while the sides of the triangle are fabric curtains joining the junction of the lobes, and serving to maintain the shape of the airship. Along each of the folds formed by the junction between the top and side lobes cables are inserted, to which are attached fabric suspension strips. At frequent intervals along these strips suspension ropes formed of bundles of cords are attached. The suspension ropes from both sides meet near the bottom of the envelope, and are continued in a cable which comes out through the bottom of the envelope at the junction of the two bottom lobes. There are four such cables, from which the car is slung, a set of the suspension ropes being taken to each. Fig. 4 gives a diagrammatic sketch of the system.

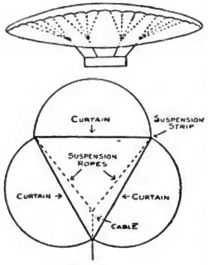

Fig. 4

THE FORLANINI TYPE

The Italian engineer Forlanini has devised a non-rigid airship (described in British Patent No. 19,898 of 1914), in which the keel is enclosed in the outer cover of the envelope, and the suspensions are internal. The envelope comprises an outer cover and an internal gas-bag, with an air space between the two, so following the practice in rigid airships. The internal gas-bag is fitted with a number of longitudinal diaphragms radiating from the longitudinal axis of the balloon, and from the junction of the diaphragms a triangular steel tube keel is suspended by wire ropes, the car being attached to this keel. The envelope is also divided longitudinally into compartments by transverse bulkheads of fabric to prevent "surging" of the gas. A diagrammatic cross-sectional view is given in Fig. 5.

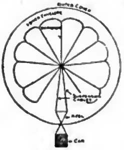

Fig. 5

THE VERDUZIO TYPE

The Verduzio airship (British Patent No. 11,922 of 1914), which is also an Italian design, is similar to the Forlanini in that both employ a keel, but the internal suspension system is more reminiscent of the Torrés-Quevédo than of the Forlanini.

The envelope is almost circular in cross-section, but has a small top lobe, to the junctions of which are attached fabric diaphragms, which meet near the top of the envelope, instead of at the bottom as in the Torrés. To the point where these diaphragms or curtains join the suspension cords are attached, from which a triangular keel is suspended (Fig. 6).

It will be noticed that in all the three of the internal rigging systems described the weight is taken on the top surface of the envelope, which has various disadvantages arising out of that mentioned earlier in this article. As has already been pointed out, a non-rigid airship is entirely dependent on the pressure of the gas for the maintenance of rigidity, so that if the pressure falls below a certain point (usually about 15 to 20 mm. of water) deformation will take place.

Now in an airship where the weight of the car is borne by the bottom surface of the envelope the effect of loss of pressure will merely be—at any rate, in mild cases—that the envelope will lose its circular shape in cross-section and will tend to become oval, a feature which will not be followed by very serious consequences.

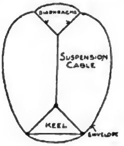

Fig. 6

In the case of an internally rigged ship, such as the Astra-Torrés, however, the envelope is unable to adjust itself to the changed conditions in this way and some other deformation must take place. The bulk of the weight being taken by the midships portion of the envelope, it is obvious that relief will take place at the ends, which will tend to rise. The effect of this will be that the airship will "break its back" and become completely unmanageable, while at the same time a considerable extra strain will be put on the forward and after guys, which will either carry away or pull through the bottom of the envelope.

In the Italian systems, where a keel is provided along practically the whole length of the envelope, this disadvantage is not fraught with such serious consequences.

Within the limits of this article it has been impossible to do more than give a general sketch of the different suspension systems employed in airship design, and no attempt has been made to go into the details of any of the different methods. Such details as have been given should, however, suffice to convey a tolerably accurate impression of the general principles of the more important types of airship which have proven successful in service, and perhaps lead the reader to indulge in further research; for which purpose the references to the patent specifications covering the different inventions may prove useful.

The Spad Biplane

Close View of the Cockpit, Machine Gun and Muffler

Pictorial Press *Official French Photograph*

The World's Air Routes and Their Regulation*

By Col. Lord Montagu of Beaulieu, C.S.I., F.R.Met.Soc., A.I.M.E.

Advising Mechanical Inspector to the Government of India

Though the time has not yet come when regular postal and commercial communication by means of the air is established, there are many signs that after the war an effort will be made by all civilized nations to develop this aspect of flying. There is need for consideration of the problems of how official, private and commercial flying must be regulated in a national and international sense.

As regards national legislation on the subject, Parliament passed a law, which came into operation in 1913, prohibiting flying over certain areas of naval and military importance, and stipulating that foreign pilots alighting in this country from abroad should descend in certain specified areas, after giving eighteen hours' notice in advance to the Home Office of their intended flight.

So far as international law is at present concerned, there can be no private or national rights in the air over the sea beyond the three-mile limit. Over the land, by the law of England, it is held that private property extends *usque ad coelum*—that is, the possession of a piece of land carries with it rights to the sky above the same area. National air rights, therefore, presumably extend all over the land of any nation, and in the case of countries with a seaboard, there must be added the fringe of the three-mile limit round the coast.

THE POSITION OF THE BRITISH EMPIRE

The British Empire is in a peculiarly favorable position for the development of Imperial aviation, for our widely separated possessions will enable our air traffic round the world, over land and sea, to proceed without having to ask for concessions from other nations. The very scattered nature of the Empire in this matter is an advantage, and the central European Powers will lose presently the advantages of their compactness. The importance of harbors and coaling stations under the British flag all over the world in the past to our naval forces and to our mercantile marine has been very great. But in future still more important will be a chain of landing places for both land and sea planes, and, for the latter, sheltered harbors will be as necessary and valuable for the development of our air services by sea as flat alighting grounds on the land for land machines.

When the map of the world is studied, it is interesting to observe that with a few exceptions our possessions are conveniently situated for flying. There is a chain of Imperial landing places southward and eastward for Gibraltar, about 900 miles from London as the plane flies, towards the Cape, to Egypt, India, and the Australasian Dominions. The nearest points between the North American Continent and Europe, the West Coast of Ireland and the East Coast of Newfoundland, are also both within the Empire.

ROUTES AND WINDS

For some time to come flying will be more easy over the land than over the sea, owing to the existence of well-organized landing places at every ten, fifteen, or twenty miles. Over the sea flying must be more difficult and dangerous to start with until the absolutely reliable engine is available and the movement of storms and the circulation of winds have been studied and their behavior can be forecasted accurately. In any case, I think it is unlikely that straight-line routes between place and place will be those that will ordinarily be adopted. In the air the currents of wind are not only far swifter than in the case of those of the sea, but so swift that an adverse wind beyond a certain point will reduce any but the fastest airplanes to the position of not being able to achieve any useful speed over the surface of the globe.

I assume in saying this that the average speed of commercial flying will probably not exceed much over eighty miles an hour for some time to come. It will never pay to fly for money-earning purposes a mile an hour faster or a foot higher in altitude than can be proved to be financially worth while. Wind currents will therefore be of supreme importance to air transport companies.

As forty to fifty-mile winds are not uncommon in the upper air in the temperate zones, while thirty-mile winds are still more frequent, it follows that it may pay to go many miles out of the direct route, geographically speaking, to secure favorable currents. It is an interesting fact, therefore, that in many cases we know already of the existence of well-defined and persistent air currents which will be of great assistance to world navigation. Another way of emphasizing this point is to realize that a continuous three-mile current in the open sea is uncommon, most regular ocean currents not exceeding more than one-half this speed. Even a three-mile current would only make a difference to a ship of seventy-two miles in twenty-four hours. Yet most courses for ships are laid out to avoid or to use such currents.

In the case of flying, even a favorable thirty-mile wind would add 720 miles to the day's run, while a head wind of a like speed would take 720 miles off the distance covered. In other words, there would be 1,440 miles difference in every twenty-four hours between a thirty-mile wind favorable to the course of the airplane and a thirty-mile wind against it—a difference so great as to make longer mileage a matter of comparative indifference.

What this may mean I have only to state that it is about 1,800 miles from a point in County Kerry in Ireland to St. John's, Newfoundland. Assuming that an airplane started from St. John's with a thirty-mile westerly wind behind it, and was capable itself of a speed of eighty miles per hour, the combined speed of 110 miles an hour over the surface of the globe would mean that in about sixteen and a half hours after leaving St. John's the seaplane or airplane could alight on the coast of Ireland.

With a contrary wind of thirty miles per hour the speed of the seaplane would be reduced to fifty miles per hour over the earth's surface, and the journey would take thirty-six hours instead of sixteen and a half, or nearly twenty hours longer.

Already there exist machines which, by substituting a load of petrol for a load of bombs, could remain in the air over sixteen hours, so I am not putting forward an impossible example.

It may be advisable, therefore, in some states of the atmosphere to fly to the North American continent *via* Iceland and Greenland; in other states of the atmosphere *via* France, Spain, Portugal, and the Azores. The reasons for these circuitous routes will be seen in some diagrams which I shall show you. It is clear, therefore, that meteorology and the study of wind currents is going to be of supreme importance. The knowledge of the world's atmospheric conditions and accurate forecasts, apart from their inherent scientific interest, may affect the saving or spending of millions of money annually, when postal and commercial aviation is established.

THE ORGANIZATION OF ROUTES

It is probable that the first great world routes to be regularly organized will be those over land, for reasons which I have already mentioned. And it should be remembered that the longer the distance the more remarkable the saving in time. For instance, there are two alternative routes to India, and beyond India to Australia and China. Before the war fourteen to fifteen days was the fastest average time by railway and mail boat to India, and about thirty days to Australia.

There is one route which will lead *via* our West African Colonies to the Cape, and another which, following the Nile, would lead to the Sudan, British East Africa, Rhodesia, and Natal.

In the northern, or land, route to and from the East I have assumed that some international arrangement will be come to by which the air above a certain level will be internationalized, following the well-established parallel of the three-mile limit round the coast. On this route five independent countries are involved besides British territory—Afghanistan, Russia, Austria-Hungary, Germany, and Holland. The distance from London to Peshawar by this route is about 3,600 miles, and from Australia about 7,000 miles.

The other Eastern route, which for purposes of identification I call the All Red Route, passes wholly over the sea and over the land of the British Empire and the three-mile sea fringe round it. It might, however, be convenient to arrange landing places with our Allies France and Portugal for the route to Gibraltar, and with France and Italy in regard to more distant landing places in Algeria, Tunis, and Tripoli.

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* Extracts from a paper read before the Aeronautical Society of Great Britain, June 21, 1917.

The route to the East by sea *via* Gibraltar is 1,600 miles longer than that which takes the more northerly course, being about 5200 miles as against 3600 miles. I do not believe continuous flying by night and day will be popular or practical for many years to come, so I allow in all my calculations for passenger services for two periods of flying every day of 600 miles each, or 10 hr. in all, which, at 120 miles an hour, would give the reasonable distance of 1200 miles covered between dawn and sunset.

I think a rest by night will be more popular than a continuance of the journey in the dark. Then, as now, the wonderful views of the earth beneath will be one of the greatest inducements to fly by day. Mails, on the other hand, will probably proceed continuously, but except in the most urgent cases passengers will, I think, be content to travel in the immensely shortened time which would be occupied, say, in getting from London to India or Australia or South Africa.

The saving would amount in the case of India to at least 11 days and in the case of Australia 23 or 24 days. As the world becomes more luxurious again there will be few, apart from enthusiasts, who will care to face the discomforts of eating, drinking, sleeping, and performing other necessities of civilized human life in what must necessarily be a cramped space.

I am of opinion also that the pilots will have regularly defined stages like engine-drivers on locomotives have their definite stages on long distance journeys. The average pilot will be unable to remain entirely alert and efficient after the strain of, say, six hours' hard flying even if he has an assistant. In addition, to know the peculiar weather conditions of any 600-mile stage across the planet's surface, the local liabilities to storms and the prevailing air currents at different times of the year will need special study in each section. I assume, therefore, that world flying, as far as passenger services are concerned, will be arranged by stages and not be continuous.

There are, of course, some oversea routes on which no intermediate stops will be possible, except in fine weather or in conjunction with areas of the ocean artificially protected and made suitable for landing by oil, balks or timber, or grass mats on a large scale to abate and subdue heavy and breaking waves.

By the Southern Atlantic route to North America the 1200 miles of the first stage to the Azores, *viâ* Portugal, will be covered comfortably in one day under ordinary circumstances, and rest secured that night, while from there the second day's flight on to St. John's, Newfoundland, will form another quite possible daylight stage. The meteorlogical importance of the Azores will be referred to later.

Assuming, therefore, the stage-by-stage system, I set out here a time-table of the two routes to India and beyond from Peshawar and Karachi respectively to London.

I—Southern Route to India

FIRST DAY.

Miles.			*Time.*
...	Croydon (London)	dep.	7 a.m.
625	Marseilles	arr.	12.30 noon.
		dep.	1.30 p.m.
485	Naples	arr.	6 p.m.
1,110			

SECOND DAY.

Miles.			*Time.*
...	Naples	dep.	7 a.m.
640	West Coast of Crete	arr.	12.15 noon.
		dep	1.15 p.m.
485	Alexandria	arr.	5.45 p.m.
1,125			

THIRD DAY.

Miles.			*Time.*
...	Alexandria	dep.	7 a.m.
580	Jof	arr.	12 noon.
		dep.	1 p.m.
460	Basra	arr.	5 p.m.
1,040			

FOURTH DAY.

Miles.			*Time.*
...	Basra	dep.	7 a.m.
575	Bandar Abbas	arr.	12 noon.
		dep.	1 p.m.
680	Karachi	arr.	6.30 p.m. ..
1,255			

Total distance, 4,530 miles.
39 hours 15 minutes actual flying time.
83 hours 30 minutes total time on journey.

II—Northern Route from India

FIRST DAY.

Miles.			*Time.*
...	Peshawar	dep.	7 a.m.
600	Bokhara	arr.	12 noon.
		dep.	1 p.m.
620	Gurieff (Caspian Sea)	arr.	6.15 p.m.
1,220			

SECOND DAY.

Miles.			*Time.*
...	Gurieff	dep.	7 a.m.
600	Lagansk	arr.	12 noon.
		dep.	1 p.m.
610	Tarnopol	arr	6 p.m.
1,210			

THIRD DAY.

Miles.			*Time.*
...	Tarnopol	dep.	7 a.m.
600	Leipzig	arr.	12 noon.
		dep.	1 p.m.
600	Hendon (London)	arr.	6 p.m.
1,200			

Total distance, 3,630 miles.
30 hours 15 minutes actual flying time.
59 hours total time on journey.

The general principle which I think should underlie all regulation of air traffic is, that slow speed planes should use the lower levels and high speed planes the upper levels of the air. I suggest five levels, stretching from the earth's surface up to 10,000 ft., through which the various kinds of traffic should be classified to pass.

The first 2000 ft. from the surface of the ground upward should be prohibited to air traffic in general, but be usable, of course, by the private owner of the soil if he desires, and for the purposes of descending to his own landing or to "dromes" or intermediate safety landing places. This must be so, for airplanes will probably form one of our commonest means of locomotion in a few years' time, and provision must be made for all traffic to land at intervals of, say, 10 or 15 miles on defined routes.

In admitting the claims that any air should be private, I conform, to some extent, to the present law of *usque ad coelum*, but I propose to limit that right to an altitude of 2000 ft. Owners of houses and land, and the dwellers upon and in them, have a moral and probably a valid legal claim to be secured some privacy from nuisances arising from air traffic.

Above this private level we come to the commercial levels, which I propose shall range from 2000 to 4000 ft. I place this class of traffic on the lowest of the flying levels, on account of the fact that commerce will want to operate as cheaply as possible, and to achieve height and speed means extra expenditure of motor spirit, whichever way it is looked at. And I would make this 2000 to 4000 ft. level usable by silenced planes only with a maximum speed of 80 m.p.h.

Above these commercial levels I propose another zone of 2000 ft., 4000 ft. to 6000 ft. for planes, also silenced, capable of speeds between 80 and 120 m.p.h. This will include the general air traffic of the planet for ordinary flying, including a proportion of fast commercial flying. As all airplanes will shortly be fitted with superchargers, or their engines designed and built for high altitudes, high flying will become quite easy.

At present the decreasing density of the air at heights, leading to falling off in engine power, is a disadvantage. This will shortly be neutralized so that the engine produces the same or even greater power at a height than at the earth's surface.

There is, of course, a height where human health and comfort will be affected, owing to the effects on the blood of decreased atmospheric pressure, such as what is called "fizzing," and the chance of faintness and heart attacks when a rapid descent takes place. The intense cold also at high altitudes will tend to keep passenger traffic, as a rule, in the lower levels, for there is a decrease of about 5 deg. F. for every 1000 ft. of height.

Above 6000 ft. to 10,000 ft. I would reserve the levels for the official planes of each nation. These levels would be used by its naval, military, and civil forces, and by police planes, for air police will be needed in the same way that policing of routes by land and sea is now necessary. Specially authorized pilots, and perhaps postal services, will also use the 6000 to 10,000 ft. levels, where the international levels will begin.

(To be continued)

Digest of the Foreign Aeronautic Press

Aeronautics (London), July 25, 1917

Snakes to be Scotched.—An editorial dealing with the attitude of the British Government in regard to the German airplane raid of July 7, on London. A deputation of members of Parliament having waited upon the Prime Minister to urge upon the Government the need for improving the aerial defences of London, Lloyd George made the following reply:

"I do not want you to go away with any idea that we do not realize the importance of defending London, not merely defending London because it contains millions of people, but because it is the capital of the Empire. I realize that there is a special case for defending London even in comparison with other towns.

"I still say on behalf of the Government that we must put the safety of the soldiers at the front first, and I say so without any hesitation. * * * A single counter-attack in France by the Germans on a small scale produces casualities greater than the whole of the casualties sustained by the civilian population, not merely in London, but in every town in Great Britain during the whole of the three years of the war. Do not therefore let us exaggerate. * * *

"Out of the twenty-two machines that came over, four were brought down. That is a pretty high percentage. It is a much higher percentage than was brought down of the French machines which crossed over the German lines just recently. In that case there were only two out of eighty-four brought down by the Germans, while we brought down four out of twenty-two."

Air Raid Grants.—Local relief committees have been appointed in Great Britain for alleviating distress caused by air raids. Advances will be made from the National Relief and Mansion House Funds. The committees have been authorized to grant immediate relief up to an amount equivalent to the rates of the Army separation allowances, the adopted scale being the following: First and second adult, $4 each; every additional adult, $2.50 each; first child, $1.75; second child, $1.25; third child 90 cents; each additional child 75 cents. Supplementary allowances are made for maintenance (if the bread-winner has been killed), replacement of articles of furniture and funeral expense are also provided for.

Aeronautics (London), August 1, 1917

Death of a Pioneer.—Another pioneer has disappeared with the death of Wing-Commander Clive Maitland Waterlow, R. N. A. S., who was killed on Friday, July 20, at Cranwell, in Lincolnshire. Commander Waterlow was thirty years of age. He was actively connected with all the early airship experiments at the Royal Aircraft Factory, and when the airships were transferred to the Admiralty early in 1914, he joined the Royal Naval Air Service. His pioneer work was invaluable; his confidence was never shaken in the future of the airship and he was of the greatest service to his country as a staunch advocate of the airship at a moment when this type of aircraft had fallen into disfavor.

Determination of Propeller Pitch. By Hugo C. Gibson.—At any distance, say, two, three or four feet from the axis of the hub, mark point A, upon the leaving edge, and B upon the entering edge of the blade. The line joining these points is at some angle to the plane of revolution of the propeller, and it is the angle at which the air is attacked, if the air is still and the propeller is not travelling through the air. Assuming that the propeller were a screw operating in a nut, then this angle would determine the distance that the screw travelled through the nut, while making one complete revolution, and this distance is called the pitch of the propeller.

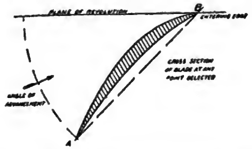
In order to determine what is the pitch, proceed as follows: —From a table of tangents, which may be found in any engineering book such as Kent's, find the tangent of the angle which was measured as indicated. Then form the equation

$$\tan A = \frac{P}{3.1416 \times D}$$

where D = the diameter of the circle swept by the points A and B, and P = pitch.

Taking an instance: Mark the points A and B at a radius of 3 ft. from the axis of the propeller hub. Then those points will swing in a circle 6 ft. in diameter, therefore $D = 6$ ft.

Suppose the angle of the line AB to be at 17°30′ to the plane of revolution, then the tangent of the angle 17°30′ is found from the tables to be 0.31530. Substitute these figures in the equation, which then becomes



$$0.31530 = \frac{P}{3.1416 \times D}.\quad \text{Therefore } P = 3.1416 \times 6 \times 3.1530$$

and $P = 5.94$ ft.

The same process can be repeated at each position along the blade, taking a new D each time.

PITCH AND DIAMETER TABLE FOR TRUE SCREW SHAPE

Pitch	Diameter in Feet and Inches—Pitch in Round Numbers.								
in ft.	2′	2′6″	3′	3′6″	4′	4′6″	5′	5′6″	6′
1	9°5′	7°13′	6°5′	5°12′	4°34′	4°5′	3°37½′	3°20′	3°4′
2	17°30′	14°30′	11°45′	10°30′	9°5′	8°15′	7°13′	6°45′	6°5′
3	25°30′	20°45′	17°30′	15°15′	13°30′	11°45′	10°45′	10°	9°5′
4	32°30′	27°	23°	20°	17°30′	16°	14°30′	13°	11°45′
5	38°15′	32°30′	28°	24°30′	21°45′	19°30′	17°30′	16°	15°
6	43°15′	37°	32°30′	28°30′	25°30′	23°	21°	19°	17°30′
7	47°45′	41°30′	36°30′	32°30′	29°	26°	24°5′	22°	20°
8	51°30′	45°15′	40°	36°	32°30′	29°15′	27°	25°	23°
9	55°10′	48°45′	43°37′	39°20′	35°37′	32°30′	29°47′	27°37′	25°30′
10	57°50′	51°50′	46°45′	42°20′	38°35′	35°15′	32°30′	30°	28°

Pitch in ft.	6′6″	7′	7′6″	8′	8′6″	9′	9′6″	10′	10′6″
1	2°47′	2°35′	2°25′	2°15′	2°7′	2°2′	1°57′	1°49′	1°43′
2	6°	5°12′	5°	4°34′	4°30′	4°5′	3°50′	3°37½′	3°30′
3	8°30′	8°	7°13′	7°	6°30′	6°5′	5°45′	5°22½′	5°12′
4	11°	10°15′	9°45′	9°5′	8°30′	8°	7°35′	7°13′	6°55′
5	13°45′	12°45′	11°45′	11°15′	10°30′	9°45′	9°15′	9°5′	8°34′
6	16°15′	15°15′	14°30′	13°7′	12°15′	11°45′	11°	10°45′	10°15′
7	18°45′	17°30′	16°15′	15°	14°15′	13°45′	13°	12°30′	11°57½′
8	21°30′	20°	18°45′	17°30′	16°15′	16°	15°	14°15′	13°33′
9	23°45′	22°15′	20°55′	19°37′	18°32′	17°35′	16°40′	15°55′	15°11′
10	26°5′	24°25′	23°	21°40′	20°30′	19°25′	18°30′	17°35′	16°45′

Pitch in ft.	11′	11′6″	12′	12′6″	13′	13′6″	14′	14′6″	15′
1	1°37′	1°34′	1°30′	1°27′	1°24′	1°21′	1°18′	1°15′	1°12′
2	3°20′	3°10′	3°4′	2°55′	2°47′	2°40′	2°35′	2°30′	2°25′
3	4°57½′	4°45′	4°34′	4°24′	4°15′	4°5′	3°55′	3°45′	3°37½′
4	6°35′	6°20′	6°5′	5°50′	5°35′	5°25′	5°12′	4°59′	4°52′
5	8°10′	7°50′	7°30′	7°13′	6°55′	6°37′	6°25′	6°15′	6°5′
6	9°49′	9°25′	9°5′	8°40′	8°19′	8°	7°44′	7°27½′	7°13′
7	11°27′	10°57′	10°30′	10°6′	9°42′	9°21′	9°5′	8°42½′	8°23′
8	13°	12°27′	11°57′	11°30′	11°4′	10°40′	10°17′	9°56′	9°36′
9	14°34′	13°57′	13°22½′	12°50′	12°22′	11°57′	11°30′	11°7′	10°45′
10	16°5′	15°25′	14°50′	14°15′	13°42′	13°15′	12°16′	12°22′	11°57′

The Aeroplane (London), July 25, 1917

The Production of Aeroplanes and Their Components. By Stephen Blakeney.—Seventh installment of a thoroughly practical course of the manufacturing and assembling of airplanes.

Flight (London), July 28, 1917

Investigating Atmospheric Pollution.—An Advisory Committee on Atmospheric Pollution has been constituted in London as an adjunct to the Meteorological Office and a grant of $2,500 has been alloted by the Department of Scientific and Industrial Research to cover the cost of the work for the current year.

Flying (London), July 18, 1917

Air Mines.—The problem of how to mine the aerial ocean against aircraft attacks will have to be solved sooner or later, says the *Sunday Times* of London. This will prove particularly necessary in view of the future determination of definite aerial mail and passenger routes, which will mean that prohibited areas cannot remain prohibited merely on paper, but must be rendered dangerous against violation.

Now, as in naval warfare, one object of mines would be to reduce the freedom of raiders and to enable our fighting craft to drive the raiders into mined areas, particularly in night time, while the mere suspicion that certain areas might be mined would deter raiders from approaching except in particular directions.

News of the Fortnight

Major Henry Souther Dies

Major Henry Souther, head of the Aircraft Engineering Division of the U. S. Army Air Service, died at the Post Hospital, Fort Monroe, after an operation, on August 15. Major Souther had been ill for about a week, but complications, which developed suddenly, made an operation imperative. He never recovered from the shock, and died a few hours afterward. The funeral was from Forest Hills Chapel, Boston. He is survived by his wife and two daughters.

Major Souther, whose distinguished career as an engineer made him one of the best-known men in his profession, was born Sept. 11, 1865. His early engineering training was received at the Massachusetts Institute of Technology, where he graduated in 1887. He was engineer for the Pennsylvania Steel Co. for five years, and for six years was with the Pope Manufacturing Co. Major Souther became one of the leading authorities on materials of the country, and opened a consulting engineering laboratory in Springfield, Mass., which he conducted for a number of years. He served as Water Commissioner in Hartford for eight years.

(c) Harris & Ewing

MAJOR HENRY SOUTHER

He was one of the most active engineers in the country in promoting standardization, and was Chairman of the Standards Committee of the Society of Automobile Engineers, later becoming President, 1910-1911.

Major Souther was called to Washington by General Squier to be consulting engineer of the Aviation Section of the Signal Corps in April, 1916. He organized the inspection department and conducted many experimental tests. He was the first civilian to accept a commission on the Officers' Reserve Corps, Aviation Section, as Major. His personality made him one of the most popular of the reserve officers in Washington. One of his duties was to act as director of Langley Field, and at the time of his death his work was largely connected with the experimental testing of machines and engines. He was a member of the American Society of Mechanical Engineers, American Society of Testing Materials, Society of Automotive Engineers. His clubs were the Hartford, Racquet and New York Engineers.

The Aircraft Board

The Senate Committee on Military Affairs has favorably reported, with amendments, the bill introduced by Senator Sheppard creating the Aircraft Board, to consist of the Chief Signal Officer of the Army, the Chief Constructor of the Navy, and not exceeding five civilian experts.

The bill empowers the proposed Aircraft Board to "supervise and direct, in accordance with the requirements prescribed or approved by the War and Navy Departments, respectively, the purchase, production and manufacture of aircraft, engines and all ordnance and instruments used in connection therewith."

Provision is made by the bill for paying the civilian members of the Board salaries of $7,500 per annum, and for the employment of technical experts and other necessary employes at salaries to be fixed by the Board.

Senator Chamberlain, chairman of the Senate Committee on Military Affairs, announced that he would press for immediate passage of the bill, which is regarded as of high importance by both the Secretaries of War and Navy, and by Chairman Coffin, of the Aircraft Production Board of the Council of National Defense.

Senator Sheppard, in reporting the bill from the committee, said:

"The Committee on Military Affairs, to which was referred the bill to create the Aircraft Board and provide for its maintenance, begs to report it back with amendments, and recommends that it be so amended and passed.

"The airplane has become an indispensable and vital weapon in modern warfare. The developments of the present world conflict have demonstrated its overwhelming importance and necessity. In recognition of these facts, Congress recently appropriated six hundred and forty million dollars for the construction of an air fleet of unparalleled proportions. It is proposed that this fleet shall be created within a year.

"This is a task of appalling magnitude. Hitherto the manufacture of airplanes in this country has been conducted on an extremely limited scale. The need of a board of experts in science and business to give special attention to the production of the necessary machines, equipment, etc., is apparent. The object of the bill under consideration is the establishment of such a board. The bill has been carefully worked out and has the approval of the President, the Secretary of War, the Secretary of the Navy, and the chairman of the Aircraft Production Board of the Council of National Defense.

Advices from Washington indicate that this bill will probably become a law at an early date.

Bill to Legalize Advance Payments

Another measure of vital importance to aeronautics has been proposed at Washington by Representative Hulbert, of New York, who introduced into the House a bill to remove the restrictions on advance payments imposed by Section 3648 of the Revised Statutes of the United States, or any other Act, as they apply to the expenditure of appropriations contained in the bill recently passed authorizing the expenditure of $640,000,000 for the increase of the Aviation Section of the Signal Corps.

Section 3648 prohibits the advance of the public moneys on contracts, etc., and the measure now under consideration is designed to permit the War Department to make such advances to responsible manufacturers, in order to enable them to increase their facilities for the production of Government aircraft. Many manufacturers of airplanes not only have valuable designs and patents, but would be in position to turn out aircraft on a large scale if they had the funds to increase their facilities.

International Standardization Committee

The International Aircraft Standardization Committee, orgaznied by the Allied Governments to affect standardization of the metals entering into the construction of airplane parts, as well as the parts themselves, held their first meeting in New York August 7. The following attended:

Frank G. Diffin, late head of the Erie Specialty Co., Chairman of the Committee, representing the United States Government; A. B. Rogers, F. C. Ericson and S. G. Payne, C. E., representing Great Britain; Capt. Alexander Pomilio and Dr. McGregor, representing Italy; Capt. Jean Herck, Capt. D. E. Chauvalon and Lieut. M. Mignot, representing France; George L. Norris, representing the Aircraft Engineering Division of the United States Signal Corps; Dr. George K. Burgess, representing the Bureau of Standards of Washington, and K. W. Zimmerschied, of the United States Aircraft Standardization Committee.

Chairman Diffin at the close of the meeting said:

"Marked results were achieved in the initial meeting. We arrived at definite decisions which will greatly hasten the construction of the thousands of airplanes needed. It is the purpose of the committee to work out the standardization of metals first, and then to work rapidly for the same result in every detail of airplane construction. The effect of this will be an enormously increased production. The results to be obtained by such quantity production are what the Allies are looking for—the supremacy of the air, which is destined to decide the outcome of the war."

Manufacturers' Aircraft Association

At a special meeting of the Manufacturers' Aircraft Association, held August 8, Samuel S. Bradley, a business man of Brooklyn, was named general manager of the Association.

Frank H. Russell, president of the Association, explained that the creation of this new office was considered desirable on account of the increasing activities of the Association, and the fact that important questions in connection with standardization and materials were constantly coming up between Army and Navy officials and members of the Association, necessitating a more intimate and continuous connection between the Association and the departments at Washington. It was also felt that the appointment of Mr. Bradley would do much to facilitate quantity production of machines and eliminate delays which have been heretofore caused by lack of a direct representative of the Association at Washington, where Mr. Bradley will spend most of his time.

Navy Will Build Aircraft Factory

The construction of an aircraft factory at the League Island Navy Yard, Philadelphia, Pa., has been authorized by the Secretary of the Navy. In making the announcement of the new plant, Secretary Daniels said:

"In view of the enormous expansion of the airplane industry now being undertaken in the United States, it was felt that it was necessary to increase the Navy Department's facilities along these lines, not only to enable it to supply a part, at least, of its own needs, but in order that the private plants might be relieved of the experimental developments which they have hitherto undertaken and turn their whole attention to the maximum production of approved types.

"Contracts have been placed for the factory on the basis of completion of buildings and beginning of operation in less than 100 days. The total cost of the buildings and plant will be in the neighborhood of $1,000,000, and it is expected that when the completed plant is working up to its capacity it will utilize the services of approximately 2,000 employes and be capable of producing 1,000 small machines per annum, or a corresponding output of the larger types.

"The Navy Department has a small flying field at the League Island Yard adjacent to the factory, and excellent facilities for seaplanes, so that it will be able to utilize this plant to keep the Navy in the forefront with the latest developments in aircraft."

Stops Export of Airplanes

The Export Council, recently appointed under authority of the Act of Congress to control export of goods from this country, has issued an order prohibiting the export of airplanes and airplane engines without special permit from the Government.

In explanation of the order, it was stated that many neutral countries were buying airplanes in considerable quantities in the United States, and as it was considered necessary in the public interest that American machines be used in the prosecution of the war, it was decided to stop the sending of machines out of the country unless by special permit.

Names for Army Flying Fields

The War Department announces that the flying field at Mineola, L. I., has been named Hazelhurst Field; that at San Diego, Cal., Rockwell Field, and at Belleville, Ill., Scott Field.

The fields at Fort Sam Houston, near San Antonio, Texas, will be known as Camp Kelly, and numbers will designate the different units.

Examinations for Aeronautical Draftsmen

The United States civil service commission will hold an open competitive examination for appointment as Government aeronautical mechanical draftsmen.

The examination is open to men only. The duties require the services of draftsmen who are experienced in detailing from automobile or aircraft layouts or assembly drawings. Salaries range from $1,200 to $1,400 a year.

The commission, anticipating the need of a great number of such men when America begins construction of her gigantic air fleet, will receive applications at any time until further notice. Forms for application may be secured from the civil service commission, Washington, or any of its branches.

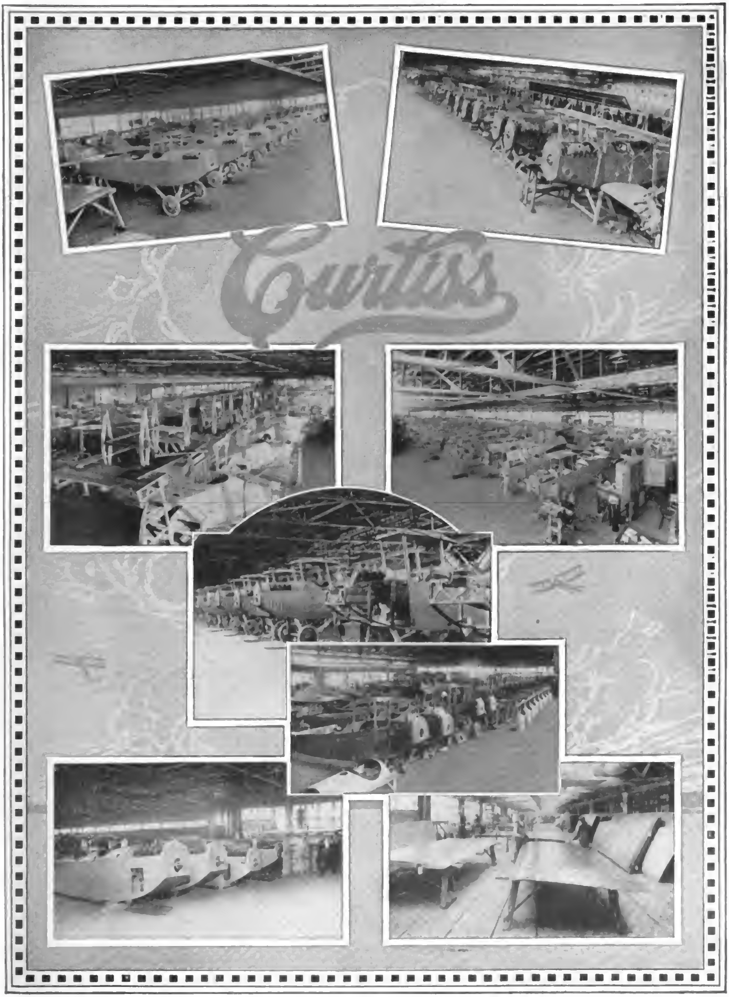
To Teach Aeronautical Engineering

Frank Edward McKone, a graduate of the Massachusetts Institute of Technology, and at present Federal inspector at the Curtiss Aeroplane and Motor Corporation, has been appointed assistant professor of mechanical engineering at the University of Washington, Seattle, Wash. He will have charge of the instruction in aeronautical engineering.

New Aircraft Companies Formed

The Journal of Commerce (New York) prints the following list of new companies organized since the first of this year, of which 33 will manufacture aircraft and the remainder munitions:

JANUARY, 1917.	
Gallaudet Aircraft Corp., N. Y.	$575,000
Davis-Warner Arms Corps., N. Y.	200,000
Wilmington Arms & Munitions Co., Delaware	700,000
Bancroft Aeroplane Co., Delaware	75,000
Total	$1,550,000
FEBRUARY, 1917.	
Silent Powderless Rapid Fire Gun Co., Delaware	$2,000,000
Canadian-American Arms Corp., Delaware	50,000
Thomas-Morse Aircraft Corp., N. Y.	400,000
Total	$2,450,000
MARCH, 1917.	
Federal Aircraft Corp., Delaware	$1,000,000
Federal Airship Co., Delaware	1,500,000
The Auto-Hydro-Aero Corp., Del.	200,000
The Hurst Aircraft Corp., N. J.	125,000
Total	$2,825,000
APRIL, 1917.	
Bates Aeroplane Co., Delaware	$500,000
Delaware Aeronautical Co., Del.	100,000
American Aircraft Corp., Illinois	98,000
Denwood Automatic Gun & Projectile Co., Delaware	100,000
General Shipbuilding & Aero Co., Delaware	1,500,000
United Airplanes Co., Delaware	1,000,000
Total	$3,298,000
MAY, 1917.	
Aeronautic Safety Navigation Co., Delaware	$350,000
A. F. Bautro Aerial Navigation Corp., Delaware	1,000,000
E. N. L. Airplane Co., Inc., N. Y.	250,000
United States Aircraft Corp., Del.	5,000,000
Walden-Hinners Co., New Jersey	100,000
Welsh Adjustable Aeroplane Co., The, Delaware	500,000
Total	$7,250,000
JUNE, 1917.	
Allied Aircraft Corp., New York	$150,000
American U-Boat & Arms Corp., Delaware	3,000,000
Aerocruiser Corp. of America, Delaware	1,000,000
Kyle, Smith Aircraft Co., W. Va.	200,000
U. S. Aeroplane Corp. of America, Delaware	1,000,000
Total	$5,350,000
JULY, 1917.	
American Aircraft Corp., Me.	$500,000
American Mine & Torpedo Corp., N.J.	100,000
Airtrades of America, Del.	500,000
Aerial Rotary Engine Co., Del.	5,000,000
California Aviation Co., Del.	400,000
Electric Cushioned Armor Co., N. J.	125,000
Falcon Mfg. Co., Del.	750,000
Fire Gun Mfg. Co., N. Y.	500,000
General Aeronautic Corp., Del.	200,000
Grant Hammond Arms Corp., N. J.	100,000
Harry E. Dey, Inc., Del.	100,000
Hourwich Aircraft Corp., N. Y.	50,000
Mills Aeroplane Corp., Del.	1,000,000
U. S. Nitrates & Ammunition Co., Del.	100,000
Western Aero Corp., N. J.	250,000
World Aeroplane Co., N. Y.	1,000,000
Total	$10,675,000



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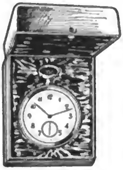

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There are watches built to stand hard, rough usage. There are very fine watches built for extreme accuracy and dependability.

* * *

There are all kinds of gasolene motors; from a one-cylinder farm motor to the finest aeroplane engine.

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Because of its very fineness, a good watch is easier to keep running accurately than a poor one.

Likewise, an aeroplane engine is many times more dependable than its cheaper brother.

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The lubrication of an aeroplane motor, because of its very fineness, should be less of a problem than the lubrication of an automobile motor.

THE problem of aeroplane motor lubrication, resolved into its simplest terms, is this:

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AEROL is, first of all, a very high grade oil, free from impurities.

Its lubricating values are very high, because it is an exceptionally good oil, made from a good crude to begin with, by a process developed through years of knowing how.

The drop in viscosity with the increase in heat is (relatively) unusually small. It is made in three grades of viscosity to meet the requirements of different types of motors.

AEROL is a practical oil because it is easily handled and flows easily. This feature is of practical utility where oil is drained off and cleaned out frequently. Also, where external feed systems are used.

Full details, characteristics and tests will be furnished to government officials, aeroplane manufacturers and others interested in the subject of aeroplane motor lubrication.

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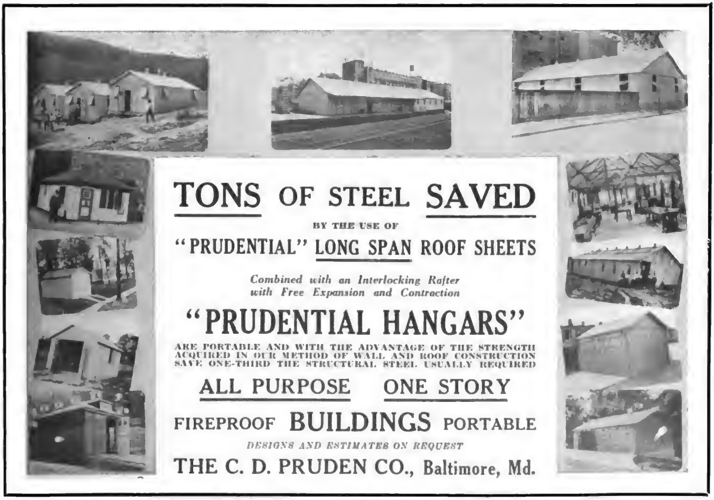

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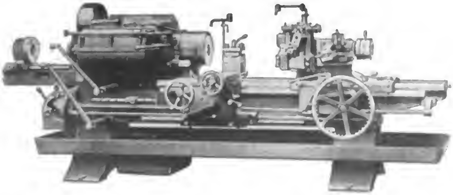

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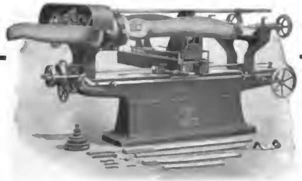

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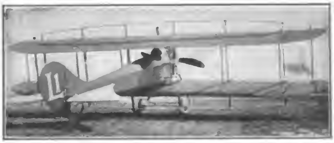

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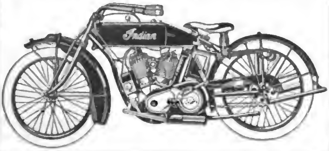

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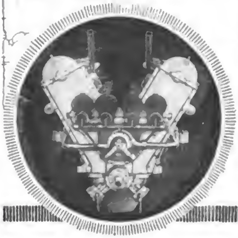

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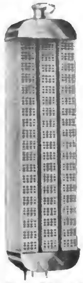

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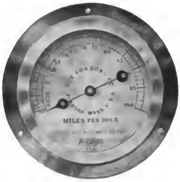

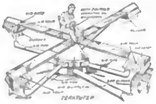

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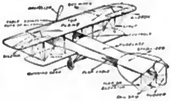

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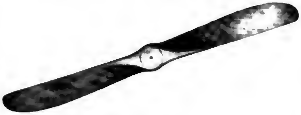

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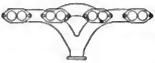

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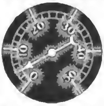

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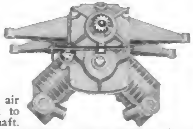

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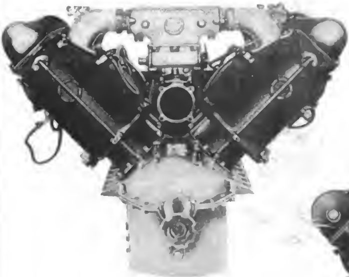

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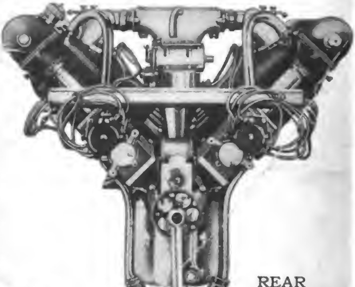

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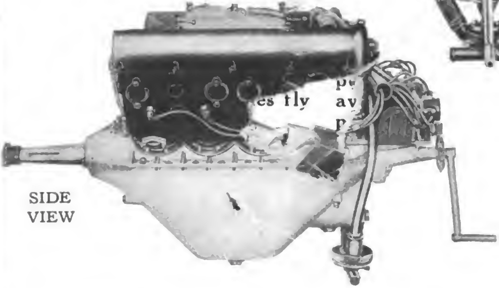

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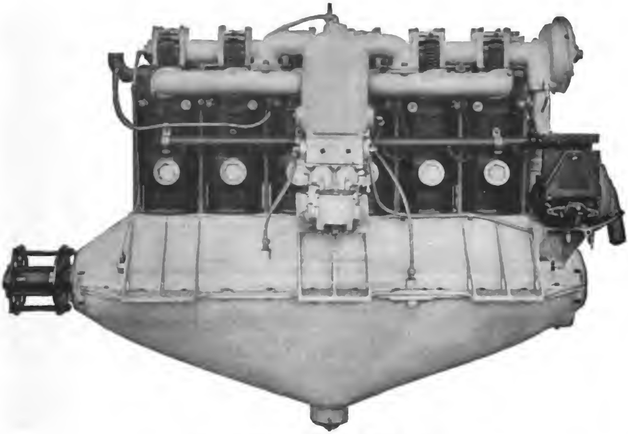

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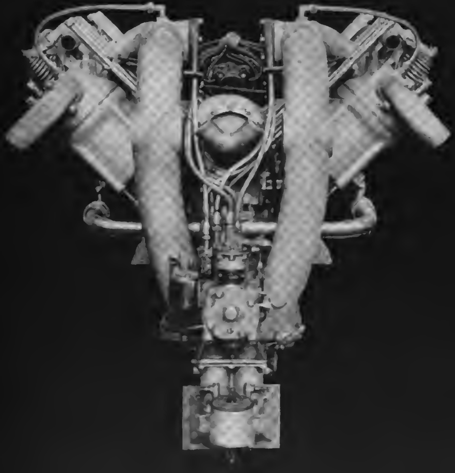

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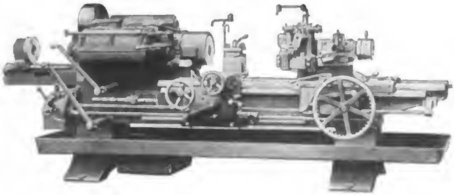

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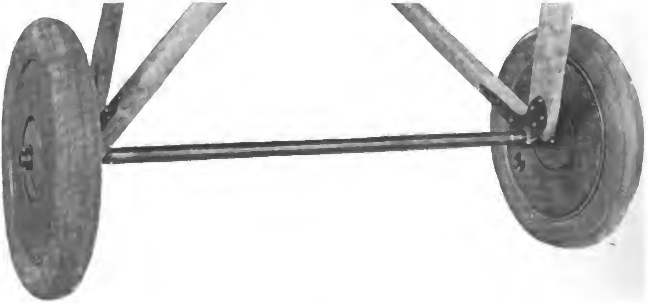

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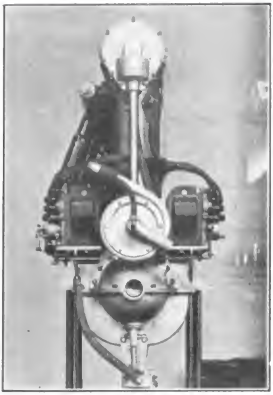

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BUSINESS MANAGER
GEORGE NEWBOLD

Vol. III September 1, 1917 No. 3

PERIODS of expectancy are as a rule difficult to bear, the more so when uncertainty and silence play a vital role in the successful prosecution of a plan. The present status of the airplane building program adopted by the Army and Navy is, so far as concerns the public, surrounded with military secrecy.

How far the construction of the several thousands of airplanes has proceeded and what results have been accomplished are and must needs be, kept from the press. Until results of military or naval importance occur, the public is expected to withhold judgment on the success or failure of the work that is being undertaken with the appropriations allotted this new service.

Rumors which have reached the public through the newspapers give the encouraging impression that a new appropriation for aircraft is likely to be asked from Congress. It is also hinted, and this should cause widespread satisfaction, that the initial appropriation of $640,000,000 is to be largely exceeded in the second request.

If the United States is to secure the mastery of the air by next spring, the requirements needed to accomplish this task will stagger the imagination of even those who thought that they had exhausted this faculty in the last year. But the knowledge that our military and naval authorities, the foreign experts, and the experienced business men who have been taken into the service are all agreed on a plan based on facts gained from the experience of our Allies, is reassuring as to the pressing need for expansion.

If those interested in our Air Service, which should include every citizen, will unflinchingly support those who are carrying out this great task, the country will find in a short time that the genius of America has once more forged the weapon which will achieve the triumph of democracy.

Scandal Hunters

One of the most fruitful sources of news is the suspicion of "graft." When all other sources of news fail, the easiest way to create a startling sensation is to gather an array of large sums and arouse a feeling of wrongdoing.

The widely printed news of the prices at which airplanes have been ordered by the Government, with the insinuation that they were excessive and extortionate, has served to bring out several statements from the authorities and constructors which have been a sufficient answer to the charges.

The public is likely to be startled when it learns of the great expense involved by the training of aviators and building of airplanes. It is generally estimated that the training of a military aviator costs between ten and twenty thousand dollars. Ground schools have to be maintained, great tracts of land must be acquired for flying fields, and a sufficient number of airplanes must be available so that one-half may be undergoing repair and overhauling while the other half is in service. Breakage is inevitable and engines rapidly wear out under the terrific strain of continually running at full power.

Motor trucks and motorcycles play an important part in the subsidiary equipment of a flying field; elaborate work shops with expert mechanics are just as much needed. All this expensive *matériel* is essential for the maintenance of efficient training stations.

The cost of the material that enters into airplane construction would be prohibitive in any other commercial product. Spruce and other woods used in airplane construction have risen to prices hitherto believed impossible. Virtually the same statement applies to linen. The metal fittings of airplanes require the finest material known to the metallurgist. The amount of manual labor expended on airplanes is so great that only those in the business realize its extent and cost.

It has been stated that the cost of applying the "dope" to the wings is greater than the cost of the linen. The only labor that can successfully be employed in airplane construction or engine work is that of the most expert wood workers and mechanics. To attract them from other fields has required great inducements. Rapid production of aircraft has called for continuous overtime charges.

Expanding organizations have been subject to wasteful experiments with half-trained, little experienced men, until real talent became available and produced the desired results. All these factors enter into the price charged to the Government; that a margin of safety should enter this price is but the manufacturer's legitimate desire to make fair profits.

Experimental work such as has been required by the Government is the most expensive of all kinds as it necessitates constant alterations of design which obviously defeat, to a large extent, the advantages derived from standardization.

The airplane manufacturers have been willing to meet the Government's prices on a fair basis and expert advice of the Aircraft Production Board can be relied upon to see that all parties will be treated fairly and that no undue advantage will be taken of the Government's position.

Controls and Control Surfaces

By W. J. Waterhouse

In the present article it is attempted to cover briefly the details of control surfaces from a structural point of view only, since much valuable information has previously been published on the aerodynamic properties of sections adapted to their use.

In past years, little attention has been given to the design of elevators, rudders, stabilizers and ailerons, as to strength; probably because of the fact that but few of the early designers realized the magnitude of the stresses actually imposed upon these members under adverse flight conditions. However, with increase in size, speed, weight and horsepower of airplanes of today, designers have displayed more skill and judgment in the design of these ever important parts.

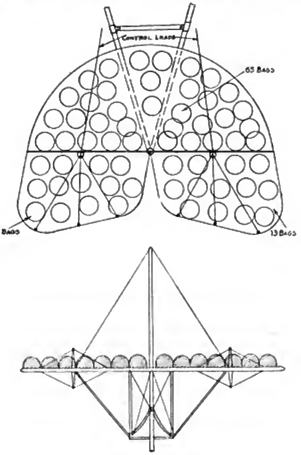

Fig. 1

The United States Army specifications require that elevators and stabilizers be so designed as to show a factor of safety of $2\frac{1}{2}$, when set at an angle of incidence of —20 deg. and —6 deg. respectively, for a speed of 100 m.p.h.

The tail surfaces of each individual airplane are bound to have some particular characteristics of their own, for each of which the designer, if experienced, has some particular object in view, either efficiency, strength or simplicity of construction. In this article, as a concrete example, the air loads on tail surfaces for the two-seater, unarmed tractor biplane of the reconnaissance type have been investigated, this type offering the following characteristics: Average weight, 2750 lb. loaded; maximum speed, 87 m.p.h.; minimum speed, 45 m.p.h.; horsepower, 150-160.

The average loading on the elevators and stabilizers for the conditions prescribed by the Government for machines of the above type and characteristics is equivalent to approximately 50 lb. per square foot for the elevators and 22 lb. per square foot for the stabilizers.

This is, however, based on the assumption that the elevators and stabilizers are working in a free and undisturbed flow of air; however, it is generally conceded that the flow of air past the stabilizer, when at high or low angles of incidence, is broken into eddies, causing considerable interference with the air pressures on the elevators and rudder while being turned through their working range of positive and negative angles, but want of reliable wind channel data regarding this effect of interference forces us to treat the subject as though no interference existed.

Tests

In tests conducted by the writer on a stabilizer and elevators the surfaces were double cambered and the structural elements were symmetrical so that the strength is the same whether the load acts vertically upward or downward.

These surfaces were attached to a jig specially designed so as to support them in the same manner as when fixed to the body; the load was applied at the top face of the surfaces only; the general arrangement of the test is shown in Fig. 1. The loads consisted of small bags of sand weighing $17\frac{1}{2}$ lb. to a bag, and were arranged as shown. The elevators sustained a distributed load of 455 lb. or 27.5 lb. per sq. ft., while the stabilizers sustained a distributed load of 2250 lb. or 55.5 lb. per sq. ft.

It might be of interest to state that at the time of failure, all wood members were unaffected, the failure of the metal fittings being responsible for the collapse of the structure. I refer to this point in construction, because investigation of most control surfaces has led me to believe that the fittings were the weakest part of the whole design.

Stabilizers or Tail Planes

Fig. 2-A shows the common trend of stabilizer design, i.e., a double cambered surface consisting of a rigid rectangular or I-section as the trailing edge *a* with the ribs *c* spaced at equal intervals, the nose of which is mortised into a curved leading edge *b* which gives it the desired shape or outline.

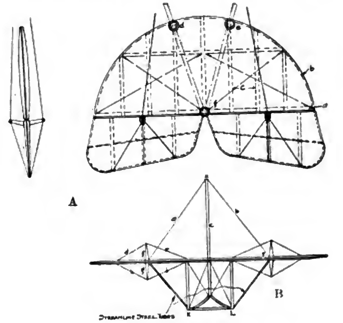

Fig. 2—A and B

Stabilizers are often made in two sections and are fitted to the sides of the body, about midway between the upper and lower longerons, but since the width of the body at the point where the stabilizer is usually attached is quite narrow, one finds that a lighter structure for the same strength can be designed by making the surface in one piece and placing it directly on top of the body. This must however be securely fastened to the longerons at the points marked *d*, *e*, and *f*, Fig. 2-A and braced at the trailing edge with streamlined steel tubing, shown in Fig. 2-B, at a point as near the elevator post as possible.

This brace can be carried directly below to some convenient point on the lower longeron, and if an elevator hinge be placed directly in front of the mast, this tube will take care of the tensile and compressive stresses caused by the pull on the control cables; but since the rudder post requires staywires *a* and *b*, Fig. 2-B; leading from the top of the post *x* to a point intersecting that of the tube *y* on the trailing edge, we see that the structure is well braced.

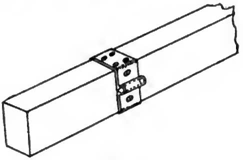

FIG. 3

Stabilizers are very simple structures, and as one can ascertain with a fair degree of accuracy the loads imposed upon them there should be no difficulty in designing a very light and strong structure.

Hinges

The old and dangerous practice of using hinges made of screw eyes, whang leather, etc., to the failure of which many serious accidents of the past can be traced, has given way to greatly improved types, and most designs of today show hinges of light but sturdy construction. For instance, the old practice of fastening hinges with wood screws as in Fig. 3, or of slotting out the beam as shown in Fig. 4 along the neutral axis, and dropping bolts through, hoping they would pass through the holes in the hinge lip, has been superseded by more reliable designs; since it was necessary to drill the holes in the lip of the hinge, Fig. 4, on assembly. The holes would not always be drilled so as to insure full strength of the hinge; in many cases these holes were found to have been drilled, as shown by the dotted half circles, and the hinge could be pulled free from the beam with but little effort.

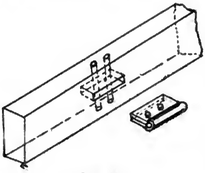

FIG. 4

The use of wood screws should be discouraged in the construction of airplanes, especially at points heavily stressed, because, as the wood ages, its structure changes, allowing the screws to eventually work free from their original seating; therefore, in no event should they be used in attaching control hinges.

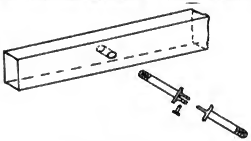

FIG. 5

There are at present several unique types of hinges displayed, but to describe them all would require too much space so I will confine my discussion to two of the most interesting.

The male and female eyebolt type, shown in Fig 5, is very light and very strong. A broad flat shoulder is usually turned just below the eye to allow sufficient bearing surface, the shanks of the bolts are passed entirely through the neutral axis of the beam; a broad flat washer offers bearing surface for the nut, which is drawn tight, and cottered, making a very reliable hinge fitting.

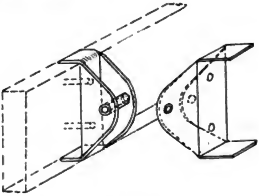

FIG. 6

The type illustrated in Fig. 6 is made from cold rolled steel, blanked out, and bent to the shape shown; this type is very sturdy in construction, but much heavier and more expensive than the eyebolt type.

Probably the only objection offered against these two types is the large space created between the trailing edge of the stabilizer and the leading edge of the elevators which allows leakage of air at that point. As a remedy for this trouble one designer has developed a type of hinge, shown in Fig. 7, that allows the two edges to butt together, but its use requires that the leading edge of the elevators, rudders, or ailerons be of steel tubing.

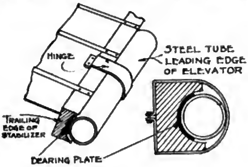
HINGE
STEEL TUBE LEADING EDGE OF ELEVATOR
TRAILING EDGE OF STABILIZER
BEARING PLATE

FIG. 7

Considering cost, weight, strength and production the eyebolt type has everything in its favor.

Elevators

In general, the design of elevators is quite similar. Fig. 8 illustrates common practice, the leading edge, *a*, consisting of either a steel tube or spruce of I-section, while the trailing edge, *b*, is either laminated wood or 5/8 in. diameter thin gauge steel tubing, flattened to a cross section of 1/4 x 3/4 in. The

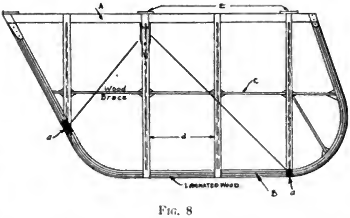

FIG. 8

ribs, *d*, usually consist of a web and batten strips made of spruce, basswood, whitewood or some other light, but strong wood, the completed structure being made rigid by cross bracing with light gauge aviator wire, or wood members as shown.

There is some difference of opinion regarding the material used for the trailing edge of ailerons, elevators, rudders and wings. In the earlier types of machines, it was common practice to lace the cloth to a wire stretched along the trailing edge and fastened at each rib. On the later machines, material mentioned above is used.

My own experience leads me to believe that the laminated wood is preferable, since it is lighter, easier to attach and has the advantage of giving way at the point of stress, in the event of striking obstructions.

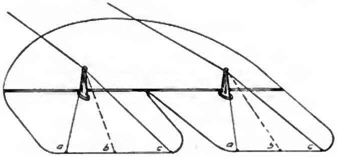

Fig. 9

As an illustration, if the trailing edge of a surface comes in contact with a root or stake and punctures the cloth, allowing the edge to pass around the object, the wooden trailing edge fails only between the two nearest points of support, and leaves the surface fit for continued service, at least until the pilot reaches his destination, and makes the necessary repairs.

This is not true, however, of a surface with a trailing edge of steel tubing, for since the tubing is many times stronger than the wood members holding it in place, it will tear free from the surface, carrying portions of the cloth and structure with it.

Where the elevators consist of a steel tube trailing edge, bent to shape and welded and riveted securely to each end of a steel tube which is used for the leading edge, it is obvious that, should the trailing edge become engaged with protruding objects, the whole surface would be swept free from the stabilizer. If the hinge connections be of sufficient strength, it may even sweep the entire group of tail surfaces off the body, leaving the pilot helpless until new ones can be attached.

The question of warping of wooden trailing edges can easily be overcome by treating the material with the proper kind of moisture proof varnishes; experiments have proven that wood properly proofed against moisture penetration will not warp.

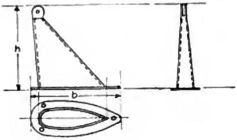

Fig. 10

As stated above, the design of elevators being quite similar to that of stabilizers one may expect similar surfaces to sustain similar loads under test, providing the manner and method of attaching hinges, braces and guy wires are similar.

It is quite obvious from Fig. 9 that an elevator supported at three points, *a*, *b*, *c*, along its trailing edge can sustain a greater uniformly distributed load than one supported at but one point, *b*. This same reasoning applies to the rudder, stabilizer and ailerons.

Some designers, in attempting to reduce the resistance of this structure, have advocated the use of a single guy wire; and on one occasion elevators were offered minus all brace wiring, the designer depending entirely on the control post to bear all stresses set up by the elevator. The weakness of the single wire and wireless practice is at once revealed by submitting them to test.

The practice of placing wireless ailerons, elevators and rudders, on high speed machines of the scout type, has proven successful; but in this case the surfaces are of high aspect ratio, thereby reducing the lever arm length of the air load on the surface to a minimum. These surfaces are also of full stream line form, and deep in cross section, allowing for rigid internal bracing. The masts are usually of minimum height, *h*, Fig. 10, and streamlined; very broad bases, *b*, are used in most cases, the major axis of which is equal to the height.

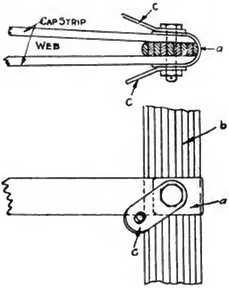

Fig. 11

It is quite true that the fewer the turnbuckles and wires, the less is the resistance offered, yet one must expect to sacrifice efficiency for strength, especially on units so important as the control surfaces.

In attaching the guy wires leading from the control post to the trailing edge of all control surfaces, great effort should be made to get the strongest combination possible; Fig. 11 illustrates a reliable fitting.

A steel strap, *a*, is passed around the trailing edge, *b*, at the point where the rib intersects same, wire terminals, *c*, being fitted above and below this point, so that a bolt passing entirely through the assembly binds it firmly to the trailing edge. With this arrangement any stress imposed upon the fitting due to the pull of the guy wire is transmitted to the steel strap putting it under tension, thus preventing the bolt from shearing through the wood; a case as would occur is shown in Fig. 12, where a bolt is passed through the rib end with no provision to prevent it shearing or splitting the wood in the direction of the force applied.

Proper location of the hinges along the leading edge means a light strong structure, and since we can estimate the load per inch run along this edge, we can calculate for a condition of hinge location that will give the best results.

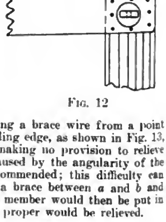

Fig. 12

The present practice of leading a brace wire from a point where the rib intersects the trailing edge, as shown in Fig. 13, to the control mast, *a*, *b*, and making no provision to relieve the rib of the bending stress caused by the angularity of the brace wire, *o*, is not to be recommended; this difficulty can easily be overcome by placing a brace between *a* and *b* and parallel to the guy wires. This member would then be put in direct compression and the ribs proper would be relieved.

Control Surface Mast

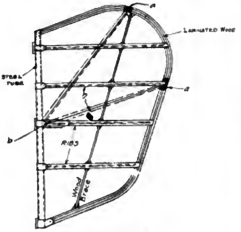

FIG. 13

Fig 14 illustrates the general type of control mast now in use. Parts *a* and *b* are stamped from sheet steel, formed to give the proper shape, and brazed. In mounting the mast in the desired position on the elevator, care must be taken to anchor the base, *b*, in such a manner that the bolts be not over stressed.

Knowing the pull on the control lead, the length of the mast, the distance between bolts, and the load on the elevator, calculation will be easy for best results; since the load on the elevator is transmitted through guy wires to the top of the mast and at that point, balanced by the pull on the control lead, we see that the stress in the mast is mostly compression.

When the angle between the control lead and the mast is acute, provision should be made for taking care of the thrust, in the horizontal plane, by wires arranged as shown at *d*, *e*, *h*, *i*, Fig. 2B.

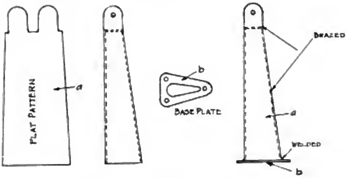

FIG. 14

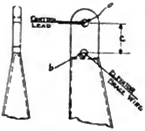

FIG. 15

During the sand loading test referred to above, the writer noted that the elevator masts designed as shown in Fig. 15 failed long before the structure showed any signs of collapse, due to the fact that the point of attachment for the control lead, *a*, was so far above the point of guy wire attachment, *b*, that the part failed by bending across the portion just below the point, *b*, owing to the horizontal component of the force, exerted through the control lead, acting through the distance, *c*. It was necessary to replace the mast with one similar in design to that shown in Fig. 16 before the test could be completed.

It will be seen from Fig. 16 that the control lead and elevator brace wires pull from the same point, thereby overcoming the cantilever effect of the pull of the control lead at the point, *a*, Fig. 15.

Control Members

The writer recently conducted tests to determine what force, in man pounds, the average pilot could exert directly upon the control levers.

The results of the investigation showed that a force of 200 lb. could be exerted in pushing or pulling upon the control bridge or yoke, 150 lb. twist or torsion upon the wheel and 200 lb. upon the foot bar.

The average control arrangement allows a ratio of 2 to 1 between the control levers and the tail surfaces, i.e., a force of twice that applied on the levers is imposed upon the tail surfaces.

These figures represent the average, since several men of different weight and strength were tried in the experiment, and conditions were ideal; therefore one can hardly expect that the pilot in actual flight would be capable of exerting such pressures, although a student pilot, in a state of fright, may exert even greater forces.

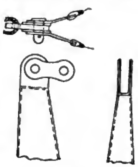

FIG. 16

In nearly every machine where the Dep. control is used it is quite common practice to pivot the control yoke at the seat rails, as shown in Fig. 17, at a point so that the distance from the axis of the yoke to the axis of the wheel is from 1½ to 2 times the distance from the yoke axis to the cable connections. This practice varies, however, with different types of machines.

While the Dep. control is very reliable, it is bulky and necessitates a wide body to prevent cramping the pilot. The stick control has proven its worth abroad. It is much lighter and less complicated and requires less width of body, for the same radius of operation given by the Dep.; it also has the advantage of being mounted to the floor thereby relieving the seat rails of considerable stress.

For large machines the Dep. control is preferable and can be installed without fear of any cramping, as the body is necessarily of sufficient width to permit the mounting of the yoke so as to allow for a roomy cockpit.

It is at once evident from the tests, that every precaution should be taken to design the seat rails, yoke and seat connections, so as to give a good margin of safety.

Considering the stresses imposed upon the seat rails, due to the effect of centrifugal force on the body of the pilot in coming out of a loop or steep dive, we find that the stresses may be increased to as much as five or six times that of the normal load.

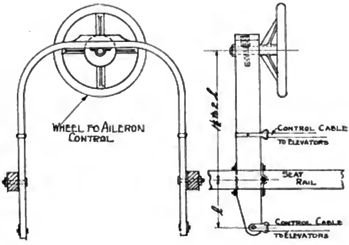

FIG. 17

That these stresses are worthy of serious consideration is evidenced by the fact that only recently a pilot in coming out of a loop was forced entirely through the seat, but regained control in time to land the machine safely. The mounting of seats, seat rails, control levers, and foot bars, deserve every consideration, for the dangers of a weak control system are unlimited.

In mounting rudder bars, some provision should be made for adjusting same, as the lengths of pilots' legs vary with their stature. Quite often flights of several hours' duration are required, and nothing is more tiresome than being compelled to hold the legs for long periods in an overstretched or a cramped position; therefore, no effort should be spared in making the pilot comfortable.

Comparative Tests of Wing Sections

By Alexander Klemin and G. M. Denkinger

In AVIATION AND AERONAUTICAL ENGINEERING for April 15, 1917, were given the results of tests on six U. S. A. wing sections. In view of the variations in efficiency with size of model and wind velocity, no true comparison can be made between such sections and others in common use unless the tests are all made on the same size of model and at the same wind speed. To make such comparison possible tests have recently been carried out at the Massachusetts Institute of Technology on the R.A.F. 3, R.A.F. 6 and Eiffel 32 sections.

These sections have been described in numerous publications since their first issue, and the exact dimensions are also given in the Oct. 1, 1916, issue of AVIATION AND AERONAUTICAL ENGINEERING. In Table 1 are tabulated values of K_y, K_x, L/D, and positions of the *C.P.* In Fig. 1 are given the curves for K_y and K_x for the various sections, and Fig. 2 those for L/D.

It will be noted that the values of K_y check very closely with the European results in every case, but that the figures for L/D are, in the case of the R.A.F. wing, better than the original ones, while, on the other hand, the Eiffel 32 sections tested at the M.I.T. gave a maximum value markedly inferior to that obtained by M. Eiffel for a similar wing.

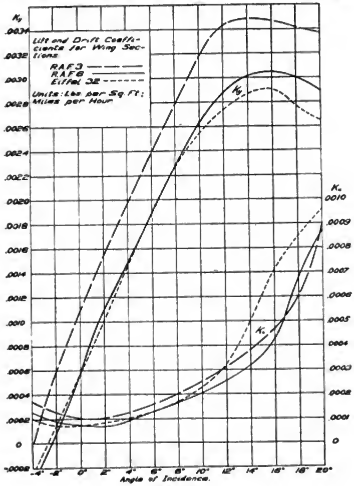

FIG. 1

The M.I.T. tests were all run at a speed of 30 m.p.h., and the models used were 18 x 3 in., whereas the tests made at the National Physical Laboratory on the R.A.F. wings were run at a speed of only 30 ft. per sec., and the models were 15 x 2½ in.

Eiffel's model was 35.4 x 5.9 in., and three tests were made, at speeds of 22.4, 44.8, and 67.2 m.p.h.

Past experiments, as well as those now under consideration, indicate that the value of K_y in a wing is virtually independent of the size of the wing and the wind speed, but that K_x depends on VL, and decreases as VL increases. The magnitude of this effect varies in different wings, and is very large in the Eiffel 32. The value usually quoted are those for the highest speed, which showed a maximum of 18.4, but the maxima for 45 and 22 m.p.h. were only 16.6 and 13.4, respectively, the last figure being inferior to that obtained at M.I.T.

It is evident from this that the superiority of the Eiffel 32 section is more apparent than real, and that, for tests under similar low-speed conditions, there are several sections which are superior to it in every way, aerodynamically speaking, except as regards the *C.P.* travel.

It is impossible to say with certainty what the relations would be at the speeds used in flight, since the effect of speed on the drift coefficient of the Eiffel 32 is so very great that it is improbable that any of the other sections would increase their maximum values of L/D in so high a degree for a change of velocity from 30 to 70 or more miles per hour. On the other hand, the Eiffel 32 has the disadvantage of a low lift coefficient.

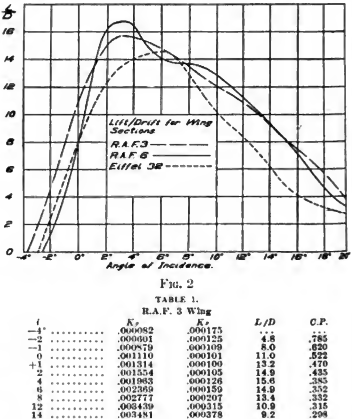

FIG. 2

TABLE 1.

R.A.F. 3 Wing

i	K_y	K_x	*L/D*	*C.P.*
−4°	.000082	.000175	...	...
−2	.000601	.000125	4.8	.785
−1	.000879	.000109	8.0	.620
0	.001110	.000101	11.0	.522
+1	.001314	.000100	13.2	.470
2	.001554	.000105	14.9	.435
4	.001963	.000126	15.6	.385
6	.002369	.000159	14.9	.352
8	.002777	.000207	13.4	.332
12	.003439	.000315	10.9	.315
14	.003481	.000378	9.2	.298
14½	.003481	.000405	8.6	.293
15	.003481	.000425	8.2	.290
16	.003472	.000465	7.4	.295
18	.003406	.000598	5.7	.328
20	.003376	.000908	3.7	.382

(N. P. L.)

R.A.F. 6

i	K_y	K_x	*L/D*	*C.P.*
−4°	−.000400	.000133	−3.44	...
−2	.000072	.000090	0.92	...
−1	.000285	.000081	3.40	.682
0	.000571	.000077	7.20	.522
1	.000821	.000069	12.10	.445
2	.001072	.000068	15.75	.401
4	.001477	.000090	16.58	.360
6	.001878	.000128	14.14	.328
8	.002268	.000167	13.69	.310
10	.002634	.000207	12.92	.298
12	.002882	.000255	11.18	.289
14	.003018	.000321	9.28	.292
16	.003045	.000434	6.92	.300
18	.002987	.000698	4.48	.319
20	.002871	.000887	3.20	.360

(M. I. T.)

EIFFEL 32

i	K_y	K_x	*L/D*	*C.P.*
−4	−.000242	.0001115	...	...
−2	+.000159	.0000735	2.2	.330
−1	.000378	.0000765	4.9	.327
0	.000591	.0000747	7.9	.320
1	.000798	.0000785	10.2	.318
2	.001011	.0000843	12.0	.310
4	.001467	.0001059	13.9	.305
6	.001894	.0001305	14.5	.304
8	.002250	.0001741	12.9	.308
12	.002732	.000324	8.4	.335
16	.002908	.000710	4.1	.357
18	.002761	.000846	3.3	.370
20	.002642	.000956	2.8	.378

(Eiffel)

Aviation Engines with Particular Reference to Benz and Mercedes Types

By E. H. Sherbondy

It was my good fortune to secure from the Baron Charles Huard two engines from airplanes which were shot down in France during the last year. These engines I have had dismantled, and am now able to give full particulars of the 170 h.p. Benz and one of the Mercedes type, which is a twin-six, and which was probably built by Renault.

The Mercedes Engine

The 150 h.p., six-cylinder Mercedes engine, which is 5½-in. bore and $6\frac{5}{16}$-in. stroke, won all the important places in the Kaiser prize contest with the exception of the first prize, which went to the Benz. The Mercedes company started with smaller-sized cylinders, namely, $3\frac{13}{16}$-in. bore and 5½-in. stroke, six cylinders. The principal features of the design are forged steel cylinders, with forged steel elbows for gas passages, pressed steel water jackets, which when welded together form the cylinder assembly, the use of inclined overhead valves operated by means of an overhead cam shaft through rocker arms which multiply with the motion of the cam. By the use of steel cylinders, not only is the weight greatly reduced, but certain freedom from distortion through unequal sections is secured, and leaks and cracks are entirely avoided. The construction is necessarily very expensive. In the details of this construction there are a number of important things, such as finished gas passages, water-cooled valve guides and a very small mass of metal, which is water-cooled surrounding the spark plug. Of course, it is necessary to use very high compression in aviation engines in order to secure high power and economy, and owing to the fact that aviation engines are worked at nearly their maximum, the heat flow through the cylinder, piston, and valves is many times higher than that encountered in automobile engines. It has been found necessary to develop special types of pistons to carry the heat from the center of the head in order to prevent pre-ignition.

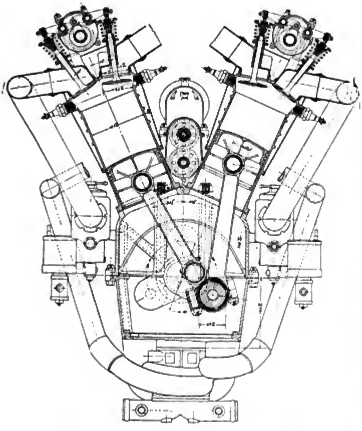

FIG. 1. TWIN-SIX MERCEDES ENGINE

In the Mercedes engine the pistons have a drop forged steel head, which includes the piston pin boss, and this head is screwed into a cast-iron skirt which has been machined inside to secure uniform wall thickness.

The carburetor used on this 150 h.p. Mercedes is precisely of the same type used on the twin-six engine, which shall hereafter be described. It has two venturi throats, in the center of which is placed the gasoline spray nozzle of conventional type fixed size orifices, immediately above which are placed two panel type throttles with side outlets. An idling or primary nozzle is arranged to discharge above the top of the venturi throat. The carburetor body is of cast aluminum and is water jacketed. It is bolted directly to the air passage, passing through the top and bottom half of the crank case, which passes down through the oil reservoir. The air before reaching the carburetor proper has, to some extent, cooled the oil in the crank chamber, and has itself been heated to assist in the vaporization. The inlet pipes themselves are copper. All the passages between the venturi throat and the inlet valve have been carefully finished and polished. The only abnormal thing in the design of this engine is the short connecting rod, which is considerably less than twice the stroke and would be considered very bad practice in motor-car engines. A short connecting rod, however, possesses two very real virtues, in that it cuts down height of the engine, and the piston passes over the bottom dead center much more slowly than with a long rod.

Other features of the design are a very stiff crank case, both halves of which are bolted together by means of long through bolts; the crank shaft main bearings are seated in the lower half of the case, instead of in the usual caps, and no provision is made for taking up the main bearings. The Mercedes company uses a plunger type of pump having mechanically operated piston valves, and it is driven by means of worm gearing.

The overhead cam shaft construction is extremely light. The cam shaft is mounted in a nearly cylindrical cast bronze case, and is driven by means of bevel gears from the crank shaft. The vertical bevel gear shaft through which the drive is taken from the crank shaft to the cam shaft operates at one and one-half times the crank shaft speeds, and the reduction to the half-time cam shaft is secured through a pair of bevels. On this vertical shaft there are mounted the water pump and a bevel gear for driving two magnetos. The water pump mounted on this shaft tends to steady the drive and avoid vibration in the gearing.

Fig. 1 illustrates the latest type of aviation engine built by the Mercedes company concerning which any information has been available. This engine is an evolution from a number of earlier types, the first of which was put into operation in 1912.

The largest Mercedes engine has recently had its horsepower increased to 176 h.p. at 1450 r.p.m. This general design of engine has been the foundation for a great many other aviation engine designs, some of which have proved very successful, but none of which, in the writer's estimation, is equal to the original.

The Renault Engine

The next engine to be considered is the V-type, twin-six Renault of $4\frac{5}{16}$-in. bore and $6\frac{5}{16}$-in. stroke. The first important peculiarity of this design is the small angle between the cylinders, which is only 47½ deg., enabling the body to be considerably narrowed in width, thus reducing the head resistance. The cylinders are almost a duplicate of the Mercedes design of steel cylinder, with the exception that the elbows in which the valves are inserted are not so carefully designed, and the water jacket is carried around only one side of the exhaust valve stem, whereas in the Mercedes the water jacket completely surrounds the exhaust valve stem. It appears to be absolutely essential to cool the exhaust valve as much as possible, since pre-ignition is likely to occur always from one of three sources—the spark plug, which is the arch offender; the exhaust valve or the center of the piston head. There are two valves per cylinder, 2⅝-in. in diameter.

It is important in aviation engines to have considerable width of seat, as it greatly assists in carrying the heat off the exhaust valve. The end of the valve stem is threaded to carry the spring cup and lock nut. Each of the cylinder bands, together with the head, are machined from a forged bar, after which the intake and exhaust elbows are welded on, and finally the pair of cylinders are encased in a jacket, which is welded up from three pieces of steel approximately $^{1}/_{32}$-in. thick. The cylinder walls themselves are $^{1}/_{64}$-in. thick. A standard two-bolt flange is used for all intake and exhaust port connections, and has been milled out of steel. The flanges are screwed on to the cylinders and welded and brazed on to the intake and exhaust pipes.

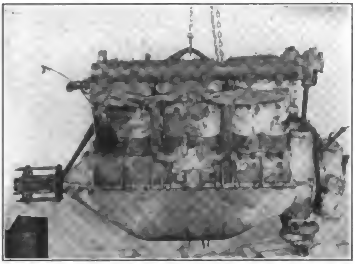

Fig. 2. Twin-Six Renault Engine, from Wrecked Airplane

The pistons are of cast iron, and are the only very heavily designed pieces in the engine. It certainly seems that these could have been considerably lightened. The piston carries three concentric rings, which are pinned at the ring gap and have a deep annular rib between the bosses. The pistons are also unusually short. There are eighteen $^{11}/_{32}$-in. holes drilled into the skirt, but these holes must have been drilled for oiling purposes, as they do not materially reduce the weight of the pistons.

The connecting rods are of the articulated type, and the short rod is alternately arranged from right to left cylinder from the front of the engine to the back.

The connecting rods are made of B.N.D. steel I-beam section, with a flange and web of approximately $^{3}/_{64}$-in. thickness. In the short connecting rod both ends of the rod are alike. The length of the rod is $11^{13}/_{16}$ in. The rod cap is secured by means of three bolts.

The crank shaft is carried in four babbitt-lined bronze shells, which in turn are secured to ribbed steel bearing caps. The bearing caps are locked in the top of case by means of long U-bolts, such as are sometimes used on automobile spring saddles. The shaft is drilled out for lightness, but oil is carried from the main bearings by means of thrower rings and separate small steel pipes to the connecting rod big ends. The front end of the crank shaft is splined to mount the starting gear and accessory drive. The bottom half of the crank case is illustrated. It simply serves as an oil pan, and has a screen separating it into two partitions. The water pump is mounted on the front of the engine from the bottom half of the crank chamber. The water is piped to either side of the engine; copper pipes and rubber connections are interposed to prevent cracking joints due to vibration.

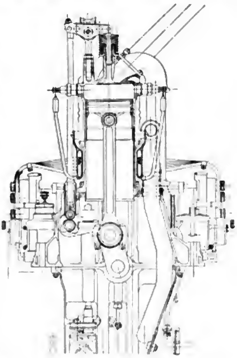

Fig. 3. End View of Six-Cylinder Benz Engine

The carburetor differs from the Mercedes only in that it uses a single float chamber instead of two float chambers. There are two carburetors mounted on either side of the engine, bolted to either side of the crank case by means of long studs. The intake pipes, which are fastened by means of unions to the carburetor, are made of copper tubing.

The carburetor has a pair of primary nozzles and a pair of secondary nozzles, and an auxiliary air valve, which consists of an annular ring mounted on concentric with a venturi throat. It would seem that this auxiliary air valve was a dangerous construction to go up in the air with, as it is very likely to stick.

The oiling system is extremely simple. Oil is to be carried through cast ducts in the front and rear compartments of the crank chamber to the main bearings. It is also carried from these ducts through two copper tubes up to the overhead cam case and passes through the cam shaft case from the propeller to the starting end of the engine, and returns down through the distributing gearing case to the oil sump.

The valve gear is of very elaborate, expensive design. The main scheme of the construction is to use a light steel tube, carried on the studs from the cylinder head, which is slotted to take bronze cages from both the cam shaft bearings and rocker arm mounting. The rocker arms are arranged to multiply the cam motion so that the valve opens $\frac{7}{16}$ in. The cam shafts are driven through straight bevel gears, and the inclined shafts which drive the cam shafts operate at three times cam shaft speed. The high speed of these shafts and the resultant lowering in torque on them allows their weight to be considerably decreased.

At first sight it would seem that the construction is a very complicated and expensive one, but this arrangement turns out cheaper and very much lighter than where a train of spur gears is used for driving magnetos, cam shafts, etc. The Peugeot company introduced the use of spur gears for overhead cam shaft driving, and this construction has been copied by Sunbeam, Wisconsin and Packard. In a twin-six or an eighteen-cylinder motor, the number of gears necessary with this gearing arrangement forms a maze of complications. There are four magnetos mounted on the same axis, each pair being driven through a spur gear, which in turn meshes with a spur gear which is slidably mounted on a splined magneto drive shaft. The magneto drive shaft terminates at its forward end in the sleeve of a bevel gear, and is helically splined into the bevel gear so that when longitudinally displaced the shaft is also angularly displaced. This construction is quite costly, but is the best one the writer has seen, since it avoids a lot of connections to magneto breaker boxes, and also insures a spark of the same intensity, regardless of whether the ignition is advanced or retarded.

At the front end of the crank shaft there is mounted an aluminum six-cylinder, air-starting motor, which engages the crank shaft by means of an overrunning clutch. This air-starting motor has a single inlet discharge valve for six cylinders of the rotating disc type. There is also built integral with this starter a hand-starting gear and the starting magneto drive.

The Benz Engine

In the Kaiser prize contest for aviation engines, a four-cylinder Benz of $5\frac{1}{8}$ x $7\frac{1}{8}$ in. won first prize, developing 103 b.h.p. at 1290 r.p.m. The fuel consumption was .462 lb. per horsepower hour. Total weight of the engine was 337 lb. The oil consumption was .044 lb. per horsepower hour. This engine was afterward expanded into a six-cylinder design, and three different sizes were built.

The three sizes were rated at 85, 100 and 150 h.p., respectively. We shall particularly consider the largest, which has six cylinders, $5\frac{1}{8}$ x $7\frac{1}{16}$ in., and which weighs 510 lb. complete. The fuel consumption is .50 lb. per horsepower hour.

The Benz cylinder is simple, straightforward and a very reliable construction, and not particularly difficult to manufacture. The cylinder is cast of iron without a water jacket, but including 45 deg. angle elbows to the valve ports. The cylinders are machined wherever possible, and at other points have been hand filed and scraped, after which a jacket which is pressed in two halves is gas welded by means of short pipes welded on to the jacket. The bottom and top of the cylinders become water galleries, and by this means separate water pipes, with their attendant weight and complications, are eliminated. Rubber rings held in aluminum clamps serve to connect the cylinders together. The whole construction turns out very neat and light. The cylinder walls are $\frac{3}{16}$-in. thick, and the combustion chamber is of cylindrical pan-cake form.

In order to insert the valves into the cylinder, the valve stem is made with two diameters, and the valve has to be cocked to insert it in the guide, which has a bronze bushing at its upper end to compensate for the smaller valve stem diameter. The valves are operated through a push rod and rocker arm construction which is exceedingly light. Rocker arm supports are steel studs with enlarged heads to take a double row ball bearing. A roller is mounted at one end of the rocker arm to impinge on the end of the valve stem, and the rocker arm has an adjustable globe stud at the other end. The push rods are light steel tubes, and have a hardened steel cup at their upper end to engage the rocker arm globe stud, and a hardened steel globe at their lower end to socket in the roller plunger.

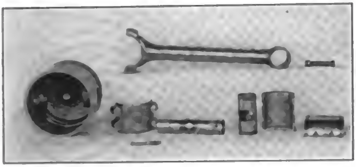

FIG. 4. PISTON, CONNECTING ROD, PISTON PIN, ETC., OF 150 H.P. BENZ ENGINE

The cam shaft is hollow, and there is a spiral gear made integrally with the shaft, in about the center of its length, for driving the oil pump gear. There is, in addition to the intake and exhaust cams, a set of half-compression cams. The shaft is moved longitudinally in its bearings by means of an eccentric to put these cams into action. At the fore end of the shaft is a driving gear flange, which is very small in diameter and very thin.

The seven bearing crank shaft is finished all over in a beautiful manner, and the shaft out of the particular engine we have shows no signs of wear whatever. Through both the crank pin and main bearings there is drilled a hole, and the crank cheeks are plugged with solder. The crank cheeks are also built to convey the lubricant to the crank pins. At the fore end of the crank cheek there is pressed on a spur driving gear. There is screwed on to the front end of the shaft a piece which forms a bevel water pump driving gear and the starting dog. At the rear end of the shaft, very close to the propeller hub mounting, there is a double thrust bearing to take the propeller thrust.

Long-shouldered studs are screwed into the lower portion of the case and pass clean through the bottom half of the case. The case is very stiff and well ribbed. The three center bearing diaphragms have double walls. The center one serves as a duct through which water pipe passes, and those on either side of the center, from the carburetor intake air passages, are enlarged in sections at one side to take the carburetor barrel throttle.

The pistons are of cast iron, and carry three concentric rings, $\frac{1}{4}$ in. wide, on their upper end, which are pinned at the joint. The top of the piston forms the frustum of a cone. The lower portion of the skirt is machined inside. Riveted to the piston head is a conical diaphragm, which contacts with the piston pin when in place and serves to carry the heat off the center of the piston.

In Fig. 4 are shown the parts of the piston and connecting rod assembly, and it will be observed that the rods are tubular and have a four-bolt construction on the big end, babbitt-lined bronze bushings, and are locked in place by means of connecting rod bolts, which pass through the sides of the bushings. The piston pin has a hole bored straight through, and is retained in the piston by means of a threaded taper pin which screws into the piston pin boss. The end of the piston pin is slotted so that the taper pin expands the end of the piston pin and forms a very certain retention.

The oil pump assembly comprises a pair of plunger pumps which draw oil from a separate outside pump, and constructed integrally with it is a gear pump, which delivers the oil under about sixty pounds pressure through a set of copper pipes in the base to the main bearings. The plunger oil pump shows great refinement of detail. A worm wheel and two eccentrics are machined up out of one piece and serve to operate the plungers. This Benz engine design is the most attractive from the manufacturing standpoint of any the writer has seen, but the progress in aviation engines has been so rapid that the design of this engine is already obsolete.

The mean effective pressures secured in this engine were probably never over 108 pounds, and there are certain of the European engines that are now giving 30 per cent higher mean effective than this. In fact, the Benz company has produced a later design with four valves per cylinder of the same size, namely, $5\frac{1}{8}$ in. x $7\frac{1}{16}$ in., which gives 225 h.p. at 1500 r.p.m. No details of this construction are available so far as is known.

The Austro-Daimler Engine

One of the first very successful aerial engines which was developed in Europe is the Austro-Daimler, which was built after the designs of Porsche. The first had four cylinders, $4\frac{3}{4} \times 5\frac{1}{2}$ in., bore and stroke, with cast-iron cylinders, overhead valves operated by means of a single rocker arm, controlled by two cams, and the valves are closed by a single leaf spring, which oscillates with the rocker arm. The cylinders are cast singly, and have either copper or steel jackets applied to them. The four-cylinder design was afterward expanded into the six-cylinder design, and still later a six-cylinder engine, $5\frac{1}{8} \times 6\frac{7}{8}$ in., was developed. This engine used an offset crank shaft. The Benz also uses an offset camshaft which improves the valve operation and changes the valve lift diagram. In my estimation, the intake pipe and carburetor arrangement on the Austro-Daimler are the best of any of the aviation engines.

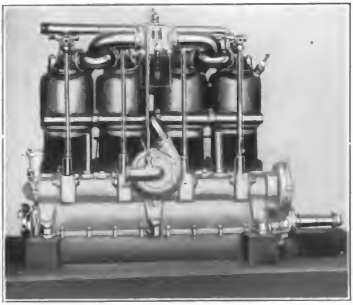

FIG. 5. FOUR-CYLINDER AUSTRO-DAIMLER ENGINE

The lubrication also is different from any other aviation engine, since individual high pressure metering pumps are used to deliver fresh oil only to the bearings and cylinders, as was the custom in automobile practice some ten years ago.

Effect of Offset Cylinders Relative to Crank Shaft

Two of the engines described, the Benz and the Austro-Daimler, use the offset crank shaft construction, and this has for a long time been quite common in German and Belgian construction. Offsetting the crank has two effects, one to cut down the guide pressure of the piston and cylinder, and the other (which is purely a secondary effect) of lengthening the stroke of the piston as the offset is increased with any given crank pin circle.

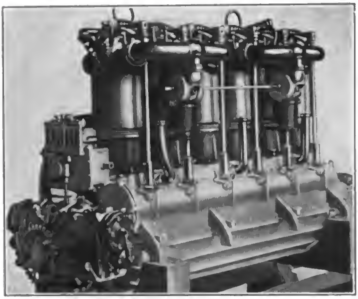

FIG. 6. SIX-CYLINDER AUSTRO-DAIMLER ENGINE

Sizes of Engines Required

It begins to be more and more apparent that engines of less than 200 h.p. have only a limited field.

In connection with the ideas that seem to be cropping up in some quarters relative to standardization of aeronautic engines, I wish to utter a warning.

What we need immediately in America is a large number of training planes; but we also will have to have battle planes driven by engines that are not equal to, but superior to, those possessed by the enemy. The real danger, in my estimation, is that the evolution of our engineering will not be fast enough. We have not as yet enough clever minds engaged in these channels, and we have not had stimulus for this sort of work. We have always had, continually in the past, that specter, cost, staring us in the face. A lieutenant in the British Royal Flying Corps said recently that there was no question of price at all if an engine would "deliver the goods." A very great deal has been done toward securing high horsepower weight efficiency by means of lightening the various parts of the structure, and I feel very certain that in a great many particulars this line of thought has reached its limit.

The really important thing about aeronautic engines from now on is going to be the number of cubic feet of mixture per minute that they can handle, and in connection with four-stroke cycle motors this points out the necessity of using relatively high speeds. The mean effective pressures arrived at in the Sunbeam engines are within 15 per cent of the theoretical maximums that are possible, and while there may be some improvement secured in the future in the matter of horsepower weight efficiency by means of further refinement in the mechanical construction, I believe that it is now necessary to ring in some changes upon the cycle of operation. This should be a splendid opportunity to try out super-compression and super-charging schemes of one sort or another, and possibly for those who have energy to try it, the two-stroke engine, with its maze of new problems, stands as an opportunity.

Blowers for Ballonets

A few months ago the Navy Department awarded contracts for the construction of several "Blimps," a type of non-rigid dirigible, similar in general design to those now being used so successfully by the Allies for scouting and coast defense purposes.

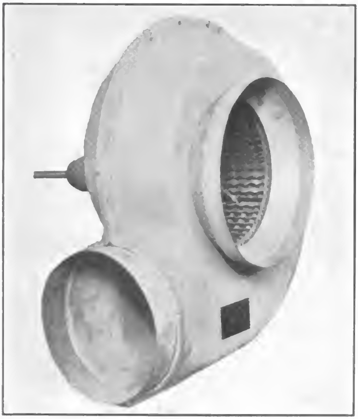

FIG 1

The trimming of a dirigible depends either upon the manipulation of horizontal rudders, the releasing of water from small containers, or by the shifting of air between ballonets or small balloons located near the bow and stern, inside of the gas envelope.

The air used in the ballonets is handled by a blower system consisting of a small gasoline engine of the motor cycle type, developing approximately 2 h.p., and a Multivane blower. The blower is driven by a V-belt or clutch, as conditions determine.

The B. F. Sturtevant Company of Hyde Park, Boston, Mass., has developed a special dirigible blower (Fig. 1) for this purpose. The excellent performance of this blower is well illustrated by the test (Fig. 2) witnessed and signed by a Government Inspector. A large number of these blowers have been delivered by the Sturtevant Company, and will be installed in all of the Government "Blimps" now on order.

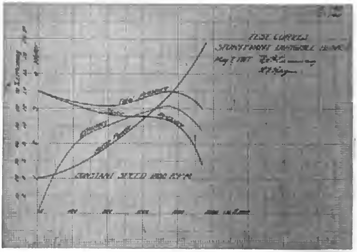

FIG. 2

The housing consists of two aluminum castings, which are remarkable from a construction standpoint, being only ⅛ in. thick. The hanger, to which the housing is attached, is also made of aluminum, and contains two ball-bearings, which support the driving shaft. The fan is of the overhung type.

The Economical Arrangement of Dry Kilns*

By Thomas D. Perry

of the Grand Rapids Veneer Works

The selection of a dry kiln for any plant involves a number of considerations and usually results in a compromise between the ideal from a kiln standpoint and the plant owner's desires. In order to simplify the compromise and promote better efficiency the following suggestions are offered to aircraft manufacturers relative the installation of dry kilns.

The day of large single kiln units, from 50 feet to 100 feet square, is gone, its place being taken by the battery of relatively small unit kilns. Modern lumber manufacturing in airplanes as well as other lines tends toward diversified kinds and thicknesses of lumber. Efficiency demands that each variety be segregated and given different treatment.

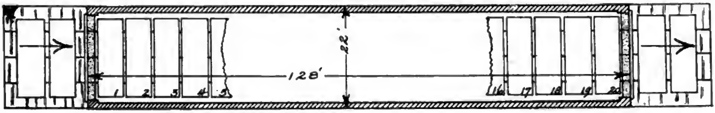

Fig. 1

The type of long progressive kiln, approximately 20 feet wide by 120 feet long, holding 20 kiln cars or 75,000 feet (BM) of lumber as shown in Fig. 1 is rarely good practice because few manufacturing operations have sufficiently uniform demands. With exceptionally uniform output this type may serve fairly well. The satisfactory use of a progressive kiln of this type requires:

I. Uniformity of lumber put in and taken out.

II. A minimum disturbance to kiln operating conditions due to the daily removal, forwarding, and insertion of one or more kiln cars of lumber.

III. An exceedingly careful regulation of heat to have it mild at the loading or entering end and hot at the unloading end. Correspondingly the humidity must be high at loading and low at unloading. A kiln less than 80 feet long will not permit the necessary variations from end to end.

The second point usually causes a loss of about ten per cent of the operating period, including the time necessary to cool the kiln so that workmen can enter to forward cars and until the interrupted operating conditions of heat and humidity are restored. The physical danger and discomfort to workmen in entering so hot a kiln on a very cold or hot day are apparent.

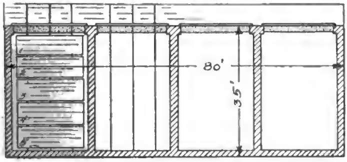

Fig. 2

The third point, the maintenance of variable conditions in different parts of the kiln, is a source of continual difficulty. The careless or unintentional overheating of the kiln in the initial stages of drying will almost always cause serious checking or casehardening of the lumber. Efficiency can only be attained by treating each kind of thickness of lumber according to its special needs. Combining several kinds of thickness in one kiln is never desirable.

The modern and efficient type of kiln is the battery of unit box or single charge kilns as shown in Fig. 2. The initial cost may be a little higher but the economy of operation is much greater. In this type of kiln the lumber is segregated into kinds, thicknesses and degrees of wetness. The total holding capacity of kilns shown in Figs. 1 and 2 is the same; i.e., 20 kiln cars or 75,000 feet of one inch lumber.

In the box kiln one unit is filled at a time, then closed, and the entire contents subjected to an initial high humidity and low temperature and these gradually modified by increasing the heat and reducing the humidity as shown on the graphic chart. At any given time the entire interior of the kiln is subject to the same condition of temperature and humidity.

Kilns of the progressive or box type may be used for lumber piled endwise (parallel to the rails) or crosswise (transversely to the rails). For work requiring such various sizes of stock as aircraft the endwise piling is preferable, because it lends itself equally well to small loads of short boards, extra long loads, or the usual 16 foot stock. Fig. 4 shows a battery of box kilns equipped for endwise piling with various kinds of lumber indicated. Fig. 2 showed a similar battery equipped for crosswise piling. In the crosswise piled kiln the lumber is not so accessible as in endwise.

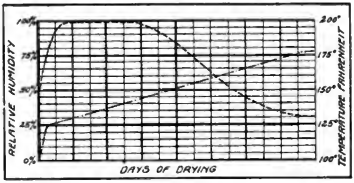

Fig. 3

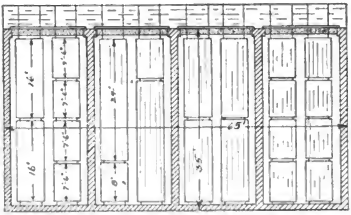

Fig. 4

The methods of using trucks under kiln cars is shown in Fig. 5.

It is rarely advisable to build kilns more than 10 ft. high from top of rail to under side of ceiling. This permits loads of lumber 8 ft. 6 in. high, leaving about 9 ft. for trucks below and 9 ft. for top clearance.

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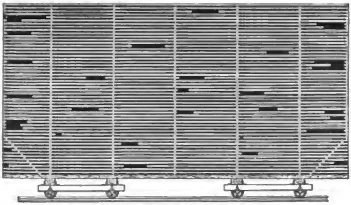
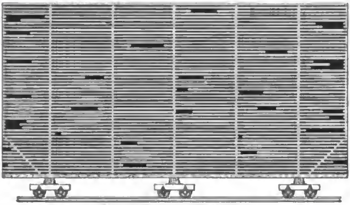
* The present article is the third of a series discussing the various phases of airplane lumber drying which have been contributed by the author to AVIATION AND AERONAUTICAL ENGINEERING. The two preceding articles, "Testing Moisture Content in Lumber" and "The Controlled Saturated Atmosphere Expansion Method of Lumber Drying," appeared in the issues of August 1 and 15, respectively.

"Stickers" or "crossings" to separate boards on kiln cars should be not less than 1½ in. wide and dressed to uniform thickness. Thick lumber requires stickers thicker in nearly the same proportion.


Side view with two endwise 48" trucks


Side view with three endwise 22" trucks

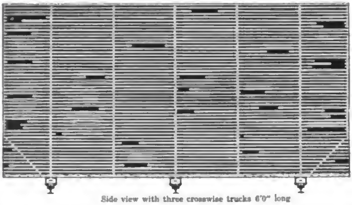

Side view with three crosswise trucks 6'0" long

FIG. 5

The following tables gives the holding capacity of kiln cars, in standard board measure, each car being 6 ft. wide by 16 ft. long by 8 ft. 6 in. high above trucks, allowing ample space for ventilation (one third of horizontal area):

Thickness lumber	Size stickers	Courses	Kiln car capacity
1"	1" x 1½"	51	3,264
1½"	1" x 1½"	41	3,936
2"	2" x 2"	26	3,328
2½"	2" x 2"	23	3,680
3"	2" x 2"	21	4,032
3½"	2" x 2"	19	4,256
4"	3" x 3"	15	3,840

There is no economy in trying to lay boards closer together nor to scrimp on the thickness of stickers. The end of a well ventilated load should appear as illustrated in Fig. 6.

Workmen will be careless about the proper placing of stickers and unless properly arranged in vertical columns the lumber will sag and be dried crooked. Devices similar to those illustrated will guard this point. The frame holding the forked guides can be raised and lowered to keep even with the point where workmen are piling lumber.

All illustrations and tabulations are based on *flat* piled lumber, although certain authorities advocate edge piling, because of the more equal exposure of the two sides of every board, and because of the increased kiln capacity possible when boards are placed with edges close together. In edge piling it is difficult to dry without warping or curling, as it is impossible to bring a sideways pressure that will be as effective as dead weight to keep all the boards flat.

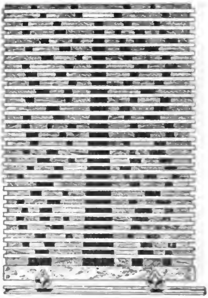


FIG. 6

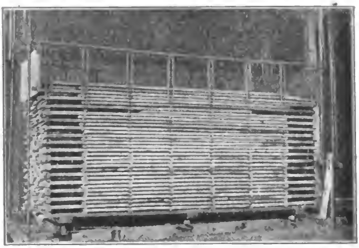


FIG. 7

FIG. 8

Transfer cars can be obtained, for either endwise or crosswise piling, to facilitate the moving of kiln cars between loading tracks, kilns, dry storage and cutting room. Be sure the transfer cars you buy are built rigid enough, as a "slimpsy" transfer car is exceedingly annoying. Transfer cars are usually about one foot high.

The use of an endwise piling transfer car as applied to Fig. 4 is shown here. Adequate loading tracks adjoining the railroad siding, ample green storage for loaded kiln cars both make for convenience in handling lumber.

Dry storage space may be inside the factory if desired, but should always be kept at factory heat and humidity. Never try to include the dry kiln inside a building; put it outside in the yard, convenient to the railway sidings, and accessible to the boiler plant for steam.

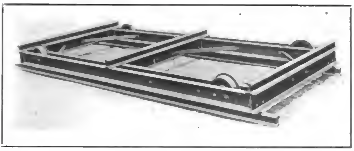


Fig. 9

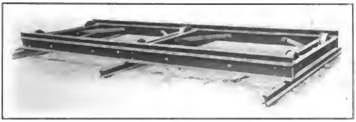


Fig. 10

Wooden doors, built of cypress, with a dead air insulating space are much better than curtains. The doors should be pliable enough to fit snug against the jambs, and to keep from warping. Don't hinge kiln doors as they are too heavy, and swinging doors take up too much room outside of the kiln. Special door carriers are made as illustrated, which lift each individual door up and out to allow it to be rolled in front of the adjacent kiln as illustrated in Fig. 12.

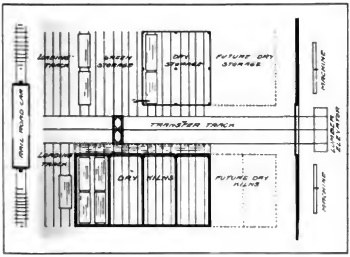


Fig. 11

Much time is usually wasted in taking lumber from kiln cars at the cut-off saw or planer. The process can be simplified and the wages of at least one man can be saved by the use of a lumber lift as indicated in Fig. 13.

This is in effect a quadruple jack screw, with a six foot range of elevation. The screws are threaded two right and two left and splined. On the foundation setting are large nuts driven by bevel gears and sprocket chains. In this way the four screws are kept in simultaneous operation. The elevator is operated by either a belt from the line shaft or by a separate motor.

The sawyer lowers his fresh load of lumber until the top of the load is within a foot of the saw table. Then as the courses are removed and cut, the lift is raised, and at the finish the lowest courses of lumber are only a foot below the saw table. With this device a sawyer will cut more lumber, and do it easier.

Enough has been indicated in this article to suggest a few of the many problems confronting the prospective kiln purchaser. In any event go slow and give heed to those who are specialists in kiln design. Adopt a comprehensive plan and provide plenty of room for logical growth as your business develops.

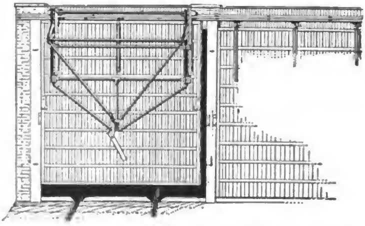


Fig. 12

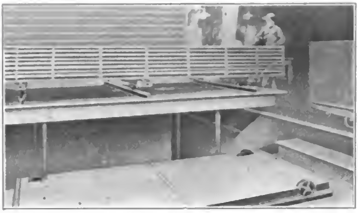


Fig. 13

Editorial Note—The cuts and diagrams are used through the courtesy of the Grand Rapids Vapor Kiln, Grand Rapids, Mich.

Calculating Static Thrust of Propellers

I cannot help taking exception to the analysis proposed by Frank W. Caldwell, for calculating, even roughly, the static thrust of propellers. It seems to me that the phenomenon is so complicated that it is absolutely impossible to present it in a brief rationalized form of this kind, and the best that can be done would be to fall back on the results of experience and to see if any kind of continuity cannot be ferreted out from the actual results.

To begin with, we all know that Renard's formula suggests the fourth power of diameter, neglecting the pitch altogether. Then, some time later, Alexander Sée, in his attempts to rationalize Riaboushinsky's results, arrived at a somewhat similar formula, which seems to check up, pretty well, with the results of tests. Here, too, the pitch was not taken into account at all, in view, I suppose, of the fact that the very conception of pitch is rather hazy. But, of course, it was not meant that either zero pitch or infinite pitch would, too, come under the formulas proposed.

Why, therefore, not to seek the correct approximation in some such formula as

$$T^s = \frac{n^2 D^4}{2750}$$

where T^s is the static thrust, n the revolutions per second, and D diameter in feet. The constant, 2750, in extreme cases varies from 2200 to 3350, which leads to a discrepancy not exceeding the limits of 20 per cent each way, being therefore satisfactory for the purpose outlined by Mr. Caldwell.

The only trouble with such rough formulas is that some one may try to get out of them more than they actually are capable of giving, apparently forgetting that no satisfactory formula can possibly be given in a problem so exceedingly difficult.

N. W. Akimoff.

The World's Air Routes and Their Regulation*

By Col. Lord Montagu of Beaulieu, C.S.I., F.R.Met.Soc., A.I.M.E.

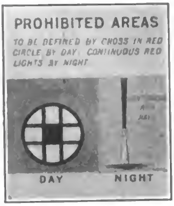
Advising Mechanical Inspector to the Government of India

Unless we are to have lawlessness and anarchy in the regions of the air there must be efficient control—this is an axiom of efficiency and civilization. Control of the levels can only be exercized, nationally and internationally, by police pilots on fast planes above the ordinary traffic, where, with the forces of gravity to aid, they can descend with a superior swiftness upon malefactors and breakers of the laws of the air, take their numbers or compel them to alight at the nearest landing place or drome.

There must also be no unsilenced machines regularly operating below 8000 ft.—I am not sure whether that limit is high enough—for even above that height the nose of many open exhausts and the hum of many propellers may become a continuous and nerve-racking nuisance. A serious amount of unpopularity and agitation against the use of unsilenced planes will have to be faced before long.

Now we come to the levels above 10,000 ft., which I propose should be internationalized. The upper air should, I think, be free to all, under certain regulations, provided pilots comply with certain rules for meeting and overtaking, and their craft passed as air-worthy—let us say, registered as A1 in a Lloyd's aerial register. This would follow the precedent, which has worked well, of the 3-mile limit at sea open to all ships of all nations.

Great altitudes will impose upon ordinary flying some disadvantages which will tend to keep international flying overland and oversea near the 10,000-ft. limit, and flying at these levels will probably, so far as international flying is concerned, be conducted along routes to be defined by methods to which I will allude presently, and in some cases nations may agree to admit international traffic to its own levels. But if a particularly cantankerous nation objects to admit any traffic to the lower levels below 10,000 ft., the air routes will not be altogether barred.


PROHIBITED AREAS
TO BE DEFINED BY CROSS IN RED CIRCLE BY DAY. CONTINUOUS RED LIGHTS BY NIGHT
DAY
NIGHT

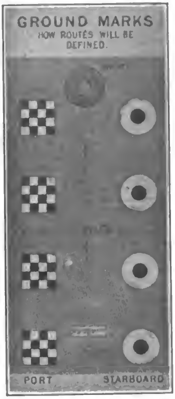
It is clear, also, that there will be prohibited areas, naval and military centers, and flying over thickly populated districts will probably be avoided on account of a certain risk to those who are still content to crawl about on the earth. But, of course, this will not preclude, as I have said, the air liners of different countries using the lower levels when necessary under license from the countries over which they pass. Then, postal and passenger services may sometimes be driven down to lower levels owing to stress of weather.

Aircraft desiring to leave their own levels will, of course, use their wireless to ask for permission from national or international flying authorities. But in this case they should conform, at least so I think, to the rules for silence and any other restrictions which may be found necessary in the lower levels to ensure the peaceful enjoyment of the earth's surface by its inhabitants. The problem of how to secure law and order on oversea routes is more difficult, and for this purpose it seems to me that we shall have eventually to define the paths to be followed within, say, certain degrees of latitude and longitude.

It is here again that international control will be necessary, and this control must be backed by international force in the shape of air police, for without force behind them conventions and international arrangements are as futile as the resolutions of The Hague Convention have proved to be. It may be, therefore, that flying over the sea outside the 3-mile limit will become a question of routes outward and homeward, with no exactly defined air levels or a fewer number of levels.

I now come to the question of how the routes chosen over continents are to be defined and traffic guided by night and by day; also how landing places are to be constructed and defined. Here, again, I think we may follow the long and proved experience of the sea. It happens that we possess a more or less agreed code of buoys and marks for defining channels, which I suggest should be imitated in the matter of the air. On the right hand, or starboard, side of all routes from the west to east, the direction in which the earth turns, there should be round marks—a white ring containing a black center.

Routes emanating from westerly points would be those whose general trend is between north and south on the westerly side of the compass. To take, for example, the routes from America to Ireland, Great Britain to Russia or India, Japan to Alaska or British Columbia, Brazil to the West Coast of Africa—on these the starboard, or right-hand, marks on land and sea alike will be white circles with a black center, while on the left, or port, side would be checker marks as shown here, square in shape.



At sea a system of large buoys may be necessary, where the depth of the sea is not too great for anchorages. And these marks, I may observe, will have to be of considerable size, probably at least 100 yards in diameter, for at 10,000 ft. these will appear mere dots on the earth's surface.

At night routes may be defined, as you see on these diagrams, by a continuous white light on the right, or starboard, side, and red and white alternating lights on the left, or port, side. These international and national routes, between countries, parts of a country, and continents should be of a minimum width of 5 miles, and in some cases a space of 10 miles may be a more suitable width when the air eventually becomes crowded. But that time is some way off.

Dromes and landing places may have to be convex and circular, on the plan shown in the diagram. The advantage of this will be that every airplane alighting will have, running uphill, the force of gravity to arrest its motion, and when starting off again, the force of gravity will equally help to give it speed to rise from the ground.

At night the principal light which will illuminate these special places will, of course, show its rays up wind, so that the pilot who is obliged to land against wind will have the light at his back and not at his face when making his landing. There must also be lights denoting the starboard and port sides, smaller green and red lights on each side of the portion of the ground on which landing is advisable.

All these lights should be movable, and be placed on trucks on rails laid down round the circumference of the landing ground, so that they can be moved as the wind shifts from one quarter to another, and in the daytime they can be used in conjunction with indication marks to achieve the same purpose. Different routes would be indicated by large white arrows on the ground with, perhaps, the initial letter E or G to say in which direction the routes were proceeded. At night such arrows would be illuminated.

The marks and lighthouses could be at intervals of 10 miles alternately each side, or 20 miles apart on the same side, as shown on the diagram, and in the case of fogs these lighthouses will help, like those concerned in navigation by sea, with wireless telegraphy and toned fog-horns. There will also be assistance given by at least two new and very recent developments of wireless telegraphy, by which direction of bodies in motion can be accurately ascertained by the helmsmen or pilots and their position in regard to fixed points on sea, land, or in the air easily ascertained. I cannot give any more precise indications at present of these new developments, which promise to be of the greatest assistance in the navigation of the air in the future. In fact, when perfected they will deprive night fog and cloud of most of their dangers.

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* Extracts from a paper read before the Aeronautical Society of Great Britain, June 21, 1917. Continued from the last issue of AVIATION.

Over the sea lightships will be usable with the same code of lights always turned upwards. There may also be on land small captive balloons at moderate altitudes illuminated at night to indicate locality to the upper levels.

GRADIENT POINTERS

Now we come to some minor, but still important points, such as to how mountains are to be surmounted. You will remember that I expressly mentioned that the "levels" should be measured from the surface of the planet, not from sea-level calculations. It follows, therefore, that when you have to cross passes through mountains, such as the Himalayas, Alps, Pyrenees, or, to come nearer home, to fly over such mere pimples in comparison as the Pennine Range, the Cheviots, or the Grampians, there will have to be some signs to show that you are nearing "rocks." Of course, to save motor spirit (probably distilled by them from coal direct, and no longer petrol), the lowest passes through mountain chains will be selected. The world's traffic lanes will, therefore, not be at the same altitude all over the world reckoning from the sea level. They will vary except over flat countries.

Let us take an instance near home, the nearest route from Newcastle to Edinburgh—over Carter Fell into Scotland—will necessitate a rise of just under 1,600 feet. Without proper warning and on a misty day or dark night, an airplane flying to the east of the point where the border is crossed might collide with the Great Cheviot, which is nearly 3,000 feet high, or nearly touch Carter Fell itself to the west of the pass. There must be, therefore, indications of gradients similar to the gradient posts of railways.

I propose that ascending and descending gradients should be made clear. These would be white patches by day and their outlines illuminated by night. Then you may legitimately ask at what level will your need for higher altitudes for your levels begin. I suggest that all altitudes from sea level to 250 feet should be considered as negligible. Above that, every 250 feet will be indicated by large figures giving the average altitude of the ground below, 500, 750, 1,000, and so on. It will be desirable, in planning regular routes, to avoid isolated high hills or groups of hills, small in area, such as Hindhead or the Malvern Hills. All routes will follow so far as possible flat country for meteorological reasons as well as I shall show presently.

HOW AIRCRAFT SHOULD BE MADE IDENTIFIABLE

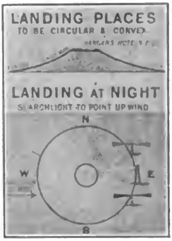
Now I come to the problem of how planes shall be designated and made identifiable. First of all there will be the nationally arranged colors of each country for those engaged in official services. Then I propose that all private planes shall be white and commercial planes red to distinguish them the one from the other. All planes, official and private, will be lettered and numbered, as decided by some international conference, such as that which settled for all countries the regulations for international motor car touring, and which allotted to each country specified lettering—GB standing for Great Britain, F for France, and D for Germany.

Pilot certificates granted by responsible countries will be recognized as valid by all those countries which signify their adherence to an international agreement, in the same way as motor drivers' licenses are now recognized everywhere.

Almost the most important of the subjects which will have to be considered in relations to the world's air routes is how weather and wind conditions will affect flying over the surface of this planet. The prevalence of trade winds is known to you all, and how they blow with unvarying regularity and strength in certain directions in certain seasons. But what is less generally known is the almost permanent existence of areas of highly barometrical pressure (sometimes called anti-cyclonic systems) in different parts of the world. These systems, though they contract and expand, have a more or less continuous effect upon the weather and winds of the world.

WIND AND WEATHER ALL IMPORTANT

Before these charts of pressure and winds can be properly understood, there are two points that must be grasped. Firstly, that wind always blows parallel to the lines of the isobars, that is, the lines of equal pressure, and, secondly, that the circulation of the wind is clock-wise in high-pressure or anti-cyclonic areas and anti-clock-wise in low pressure or cyclonic areas. This is known as the Buys Ballot Law, which in the southern hemisphere equally applies in an opposite sense.



Now you will observe that the weather of Western Europe, with which we are mostly concerned, is largely governed by two factors, the tendency to a low pressure trough more or less, all the year round, between Greenland and Iceland, and the high pressure area, which is permanent, though varying in area near the Azores. There is another seasonal high pressure area in the Sahara over North Africa, between the West Coast and the Sudan, during the winter time, as has just been proved by Major Lyons, the President of the Royal Meteorological Society, in a recent paper. Then there is a nearly constant area of high pressure north of the Himalayas, over Southern Siberia and Turkestan.

The low-pressure systems in the European and Western Asian areas are more seasonal and variable in character. There is a trough of low pressure, which lies between the Persian Gulf and the Western Himalayas, between May and October, which is the origin of the southwest monsoon so strongly felt in the Arabian Sea and over the western and northern parts of India. Then, nearer home, there is another area of low pressure generally prevalent over the Adriatic, the Northern Mediterranean and the Balkan States, which is characteristic rather of the winter than the summer months, producing a tendency to westerly winds in the Mediterranean and corresponding easterly winds to the northward of the Carpathians.

Now the systems, and the consequent tendencies to a permanent direction of wind either all the year round or at certain well-defined seasons, have a most important bearing on the world's air routes. For instance, the route homeward from India during the greater part of the year will be far easier through Afghanistan, Russia, Germany, and by what I may call the northern route, than by a more southern course, for easterly winds or calms predominate. On the outward or eastward journey, however, the route is across France, by the Rhone Valley, where the wind is often northwesterly, sometimes called the "Mistral," to Marseilles, whence we shall go either across the lower Alps to Italy, and follow the coast to the heel of Italy. Or we shall fly via Sardinia to Malta, whence by Tunis we get to Egypt.

The alternative routes will be from Brindisi to Alexandria direct about 900 miles, or from Taranto to Malta. Thus the eastward and westward routes to India, the Central European and Mediterranean may be spread apart by a thousand miles at their extreme point of divergence, and yet be the quickest routes and the cheapest to fly. In fact, wind will matter far more than mileage.

EASTERN ROUTES AS AFFECTED BY WINDS

Now let us take the outward Eastern route in detail and see how the winds will help on an average winter day. Starting, say, from Hendon or, perhaps, Croydon—for I assume that two great starting and landing places will exist for northern and southern routes to and from London—in the first flight Marseilles will be reached, where a descent for lunch will be made, the 600 miles—I give round figures—having been covered in about five to six hours. This portion of the route will be affected on about 80 per cent. of the days of the year, first by westerly and later by northwesterly winds, that is, either cross or negative and favorable currents.

Next, some point near Taranto or Brindisi or at Malta itself will be the next stopping place. This part of the journey will probably be done by seaplace in order to avoid the longer route round the Bay of Genoa and the leg of Italy. The prevailing wind over this section will be northwest to start with, and afterward light airs from the southwestward will be encountered. The "mistral" often extends in a modified form on many days in winter to a point as far as the south end of Sardinia, where the more westerly current supersedes it. The winds on the first day will, therefore, be favorable on the average.

SECOND DAY'S JOURNEY

On the second day, whether we start from Brindisi for Alexandria direct or fly via Malta and Tunis or Tripoli, a westerly wind will prevail, as a rule, near the African coast, though a moderate easterly wind is sometimes met with in the neighborhood of Malta from September to April.

On this second day's journey, by evening you will have reached either some point between Malta and Alexandria on the Tripoli coast, or more likely Alexandria itself, only 850 miles from Malta. Egypt is situated in a region where calms or light winds predominate, with the exception of the disagreeable sand-laden "Khamseen," the strong westerly wind from the desert, which, however, is favorable to progress eastward.

We then proceed eastward over the Arabian desert, where calms and light winds are the rule, a state of atmosphere which prevails all the way to Karachi, except in the monsoon period, when the northwest wind is also in our favor. In the Persian Gulf the isobars for the greater part of the year show a prevalence of northwesterly currents, also favorable. At Karachi in the winter, during the day, wind of considerable strength from the southwest is produced by the great difference of temperature between the Arabian Sea and the heated areas of the Sind desert behind it. Flying on southeastward toward Bombay or northeastward toward Delhi, there is no decided unfavorable current on the average.

REVERSE WINDS FOR HOME PASSAGE

I have not time to examine in detail all possible routes, but on the homeward passage, the reverse side of these winds, favorable for flying eastward is available. There is no doubt about the prevalence of easterly and southeasterly winds throughout the monsoon period, lasting from the middle of May to the end of October, in all the country we should use for our westward journeys through Afghanistan and through the neighborhood of the Aral and Caspian Seas.

Our first day's journey homeward takes us to Gurieff, following the average isobars. And once the corner of the Hindu Kush has been crossed at about 5,800 feet, the country all the way to England is marvelously flat, which favors the absence of wind.

The next day we leave the head of the Caspian Sea, and arrive via Lugansk at Tarnopol near Lemberg. Here, again, we leave the mountain systems of the Caucasus, the Balkans, and the Carpathians to the south of our route. The next and third day we have to face the chances of westerly winds against us when approaching the North Sea and Channel, which, however, lose much of their force inland.

THE WIND OUR FRIEND

Of course, there will be special atmospheric conditions from time to time which will involve alteration from the average courses recommended for over-sea and over-continental flying. There may be, to take a common instance in summer, an extensive "low" over France or over the mouth of the Channel involving strong easterly winds blowing from our western shores far out into the Atlantic to a point at which the Azores "high" is joined up with another "high" near the Atlantic coast.

In such a case a seaplane could, with the probability of a favorable wind over the greater part of the passage, fly from County Kerry to St. John's, Newfoundland, in a shorter time and with less expenditure of petrol than by any other route. And in flying westward you will be sun-chasing.

In our English latitudes of 51 to 55, the earth's motion does not exceed about 650 miles an hour, and though we shall not be able to fly quite fast enough yet round the planet to keep the sun over our heads continuously, still at 120 miles an hour we shall lengthen our day very considerably.

In the case of crossing the Atlantic there will be a gain of about four hours between Ireland and Newfoundland, which means that leaving Ireland at 7 a. m. on a summer morning, if an average of 110 miles an hour is maintained, you will reach St. John's in 16½ hours actual elapsed time, from which four hours must be deducted in point of solar time. Thus you will leave Ireland after breakfast at 7 a. m. and reach Newfoundland at 7.30 p. m. by local time in time for dinner. Coming eastward, your daylight will be shortened by the same time, and, except in the summer months, a start before dawn or an arrival after sunset will be inevitable.

I cannot deal on the present occasion with other weather conditions such as fog, except to mention that fog exists chiefly in certain latitudes and generally coincides with calm weather, or, at any rate, very light winds. Rain, snow, and hail I disregard, for they will be negligible to the planes of the future, though large hailstones may be harmful to propellers or even wings; but hailstorms are local, as a rule, and can be avoided. The ability also of airplanes to avoid or rise to a height above local disturbances will be the solution of many of these difficulties, for heavy precipitation, generally speaking, arises in levels lower than 10,000 feet.

A GENERAL LAW FOR FLYING

Applying the results of the Buy Ballot law, we arrive at another proposition, which will be accepted by meteorologists, that when the weather at any spot in the northern hemisphere is under the influence of low-pressure areas, and if the passage of the centers is near the place from which the pilot is flying westward, he will start on a northerly course at first. In like manner, when he desires to fly in an easterly direction, he will take a southerly course to start with. If, on the other hand, the weather is under the influence of a high-pressure area, these rules will be exactly reversed.

There is another point which every experienced pilot is aware of but which is not generally known to the public. The higher you fly the more the wind tends to turn to the right. That is to say, if on the ground you find a westerly wind, the wind at 5,000 feet will probably be W. N. W., and at 10,000 feet probably N.W. The cause of this is found in the rotation of the earth, but I cannot dilate on this here.

Now I come to the conclusion of my lecture, and I desire to summarize the principal points.

THREE POINTS OF IMPORTANCE

Firstly—As soon as war is over there must be national and international laws for the regulation of flying.

Secondly—Over-sea and over-continental routes must be defined in the interests of the whole world.

Thirdly—The winds of the world, instead of being a drawback to flying over the surface of the planet, will, if properly used, prove to be of great assistance.

LIFE AND MONEY SPENT ON AVIATION NOT WASTED

The progress of aviation, owing to its immense and increasing importance in the war for naval and military purposes, has been extraordinarily rapid during the last three years. The decisive military and naval results which a real preponderance of air power would bring about are at last beginning to be realized. Nations are spending millions of money upon the development of flying, and thousands of brave men have sacrificed their lives, both in fighting and experimental work. There has been a prodigal expenditure of life and treasure and a wonderful concentration of brains and energy on aviation for destroying human life and wrecking property. But when peace once more comes, this output of human life and skill will prove not unproductive. Unlike the expenditure of all kinds in producing forts, battleships, guns, shells, powder, missiles, gas and horrible and ingenious ways of killing, resulting in nothing useful to the human race in future, the forced development of aviation will, perhaps, be the war's most useful legacy.

WE BEG TO ANNOUNCE, IN THESE PAGES, WHAT IS AN IMPORTANT STEP IN THE PROGRESS OF THE AERONAUTIC INDUSTRY—AND THE MOST REMARKABLE DEVELOPMENT IN THE HISTORY OF OUR COMPANY

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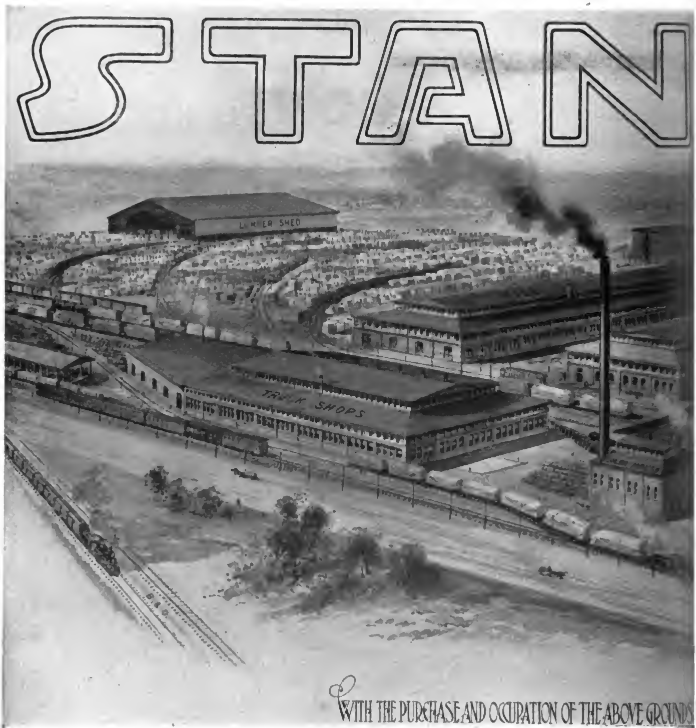

WITH THE PURCHASE AND OCCUPATION OF THE ABOVE GROUNDS
FIELD AND WATER FRONTAGE, THE STANDARD AERO CORPORATION
UNDER ONE ROOF IN THIS COUNTRY, THE PLANT, FORMERLY THE J.G
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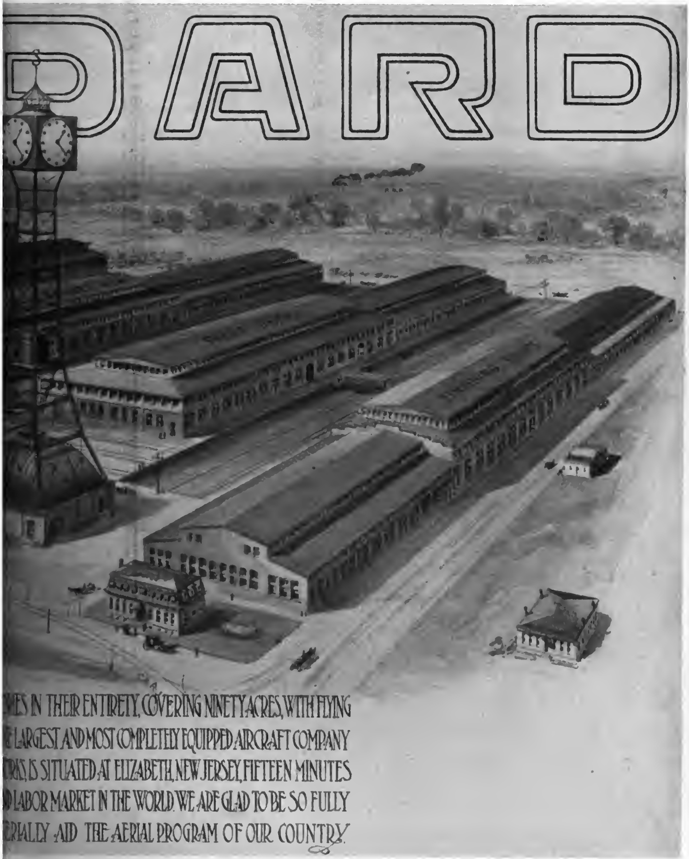

IES IN THEIR ENTIRETY, COVERING NINETY ACRES, WITH FLYING
E LARGEST AND MOST COMPLETELY EQUIPPED AIRCRAFT COMPANY
ORKS, IS SITUATED AT ELIZABETH, NEW JERSEY, FIFTEEN MINUTES
D LABOR MARKET IN THE WORLD. WE ARE GLAD TO BE SO FULLY
ERIALLY AID THE AERIAL PROGRAM OF OUR COUNTRY.

STANDARD AIRPLANES SHALL BE MADE WITH GREAT CARE AND DILIGENCE, AS IN THE PAST, SO THAT EACH PLANE MAY BE DEPENDABLE AND TRUSTWORTHY

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Digest of the Foreign Aeronautical Press

Espana Automovil (Madrid), July 15, 1917

On Aerial Warfare.—Captain Herrera, of the Spanish Army, who was recently given an opportunity to visit the French and British air fleets on the Western front, gives the following details on the aircraft he was permitted to examine:

The fighting airplanes of both the French and the British are, as a rule, small one-seater tractor biplanes in which the functions of the pilot coincide with those of a gunner. The armament consists of one, two or even three machine guns which mostly fire through the propeller by means of a synchronizing service. In this case, in order to aim, the whole machine must be directed on the target.

Such are, in the French aviation service, the Blériot and Spad biplanes, which are fitted with a 150 hp. or a 200 hp. Hispano-Suiza stationary engine, and the Nieuport biplane, which carries a 150 hp. Le Rhône rotary engine. All these machines are capable of attaining speeds of from 190 to 210 kilometers per hour.

The British Royal Flying Corps employs, besides the above described Nieuport, chiefly Sopwith biplanes and triplanes fitted with a 130 hp. Clerget rotary engine.

The French employ, however, numerous two- and three-seated pusher biplanes which mount much heavier armament, namely, 37 mm. and 47 mm. Q. F. guns; these are to be found on the three-seater Voisin (200 hp. Peugeot or Hispano-Suiza) biplane and on the two-seater Bréguet (250 hp. Renault) biplane. These machines are chiefly employed for patrol work around large cities which are within raiding distance of the enemy. They are provided with a particularly sturdy chassis and a special lighting system enabling them to start and land by night. These features cause them also to be used to a great extent for night bombardments, but in such case it is usual to carry lighter armament, that is, one or two machine guns only.

The Royal Flying Corps employs for bombing chiefly the 130 hp. Clerget engined Sopwith biplane, a two-seater, mounting two machine guns, firing fore and aft, respectively; the Handley Page biplane, fitted with two 280 hp. Rolls-Royce engines; and the one-seater Martinsyde (140 hp. Beardmore) biplane.

While the British use many of their fighting and bombing machines for reconnaissance work, the French specialize airplanes for the latter function. Among the French reconnaissance airplanes the most noteworthy are the 160 hp. Renault-Farman pusher biplane, a two-seater mounting one or two machine guns; the Letord biplane, fitted with two 150 hp. Hispano-Suiza engines, which mount four machine guns, two of which can fire forward and two aft; and the three-seater Moineau biplane which carries a similar battery and is propelled by two 240 hp. Canton-Unné engines.

Captain Herrera finally notes that besides small non-rigid airships, the rigid Zeppelin type, with two engine cars, a connecting gangway, and four lateral propellers, is now also represented in the airship fleets of the Allies.

Flight (London), August 9, 1917

One Air Service, One Uniform, One Badge.—An editorial indicative of the widespread agitation going on in England regarding the unification of the Royal Flying Corps and the Royal Naval Air Service into an Imperial Air Service.

"Instead of recognizing the obvious and doing what will have to be done sooner or later, the Government goes on with its attempts to reorganize the air services on a basis which the tests of war have shown to be radically unsound.

"It is unsound, no matter from what point of view it is regarded. In the wider operations of the war it has failed in strategy, in that it has no strategy. It has created a line of demarcation between the two fighting branches which has been productive of endless jealousy and friction. It has been wasteful of money and it has stifled output, so that the country has not even received decent value for the money that has not been actually thrown away. All along the line the system has been a proved failure—and yet we keep on attempting to "reorganize" instead of getting rid of it, root and branch, in favor of the scheme that *would* work. * * * Opinion is unanimous that there is only the one thing to be done—to carry out at once the policy which is embodied in the words which head this article."

Flying (London), August 1, 1917

The Battle for Observation. By Hilaire Belloc.—Since war became an organized affair every action has consisted of two parts, namely observation, and the piercing or turning of a line.

Observation means (1) offensively, the knowledge of what and where your opponent is, and (2) defensively, the prevention of your opponent knowing what and where you are. Until the advent of aircraft, observation was effected by the examination of prisoners, reports of spies, and the feeling out of the enemy by a screen of cavalry spread out in front of your own army.

With the advent of aircraft, observation became a different matter. Aircraft permitted you to see nearly all that the enemy was doing in fair weather during daytime; to photograph his positions, and to embarass him by bombing his communications and stores.

But this increased power of observation brought about a novel condition in warfare, that of fighting the enemy in order to prevent him from getting similar observation. Unlike in the old days of cavalry action no screen can be established in the air, where the three-dimensional movement of aircraft enables the enemy to escape above or below your action.

There exists then today a thing undreamt of three years ago, the battle for observation. This has taken on functions outside itself. The aircraft force which wins over its opponent the power of observation is also essential to the management of guns. For observation nowadays not only tells you what the enemy is doing and how he stands, but also directs—is essential to directing—your own fire.

Therefore, *to win the battle in the air is an absolute condition of success* not only in the function of observation and the regulation of artillery preparation, but also as an adjunct to the advance when airplanes support the infantry.

Flying (London), August 8, 1917

Raid Risks and Street Risks.—The Home Secretary is authority for the statement that since the beginning of the war up to date more than six times as many persons have been killed and more than sixty-seven times as many persons have been injured in street accidents in the London metropolitan area as in air raids. The official figures are the following:

	Killed	Injured	Total
Air raids	366	1.092	1,158
Street acidents	2,412	70,863	73,275

The moral is, says *Flying*, that pedestrians should read the warnings issued by motor-'bus companies as carefully as the warnings issued by the police with regard to air raids.

L'Aerophile (Paris), July 1-15, 1917

Aerial Mail Routes.—The Italian Ministry of Post and Telegraphs inaugurated on June 27 a daily postal seaplane service between Continental Italy and Sardinia on the line Civitavecchia-Terranuova. Each seaplane carries 200 Kilograms (440 lb.) of mail and covers the trip in approximately two hours.

The success of this service has prompted the French Ministry of Post and Telegraphs to organize an aerial mail route between France and Corsica. For this service military machines inapt for war service but otherwise efficient as weight carriers will be employed.

The administration of Algeria has just concluded an inquiry regarding the establishment of an aerial mail service across the Sahara Desert. It is ultimately intended to open a postal airplane route between Paris and Timbouctou; the total flying time is to be 30 hours and relay stations will be provided at Marseilles, Algiers and In-Salah.

The Aeroplane (London), August 1, 1917

On Some Directions for Reform.—The enormous wastage of lumber and of labor in the manufacture of four-bladed propellers causes an anonymous English propeller maker to make the following suggestions for the economizing of material and man-hours.

"It is quite an easy matter to economize fully 80 per cent of the timber and to increase the output by 120 per cent, by abandoning the geared down four-blader in favor of the direct-driven two-blader.

"A two-blader made (in England) for the 150 hp. Hispano-Suiza-Spad gave, in competition with the leading French and English propellers, the best climb and horizontal speed, and had a diameter of only 7 ft. 8 in., with a weight of only 17 lb., and the amount of timber used (averaged over 100 propellers) was 26 superficial feet per propeller. The time required for shaping was less than 25 hours.

"This compares very favorably with any of the official designs. The R.A.F. four-blader propeller for the R.A.F. 4a engine of less power, for instance, requires over 120 superficial feet, and takes 75 hours for shaping.

"A better designed four-blader for the same engine would require about 80 ft. super. of mahogany, but if the propeller speed was increased, a smaller two-blader, requiring not more than from 30 to 40 ft. super. could be designed to give quite satisfactory results."

To remedy this wastage, the following recommendations are made:

(1) Increase in propeller speed instead of gearing down.

(2) Two-blader propellers only.

(3) Alterations in principle of design. The propeller design on present principles, although adopted over the whole world, does not seem to give the best results that can be obtained; experiments conducted by the manufacturer mentioned seem to indicate that a slightly different principle of design gives better results.

(4) A standard engine-boss fitting, with a bore of not more than 70 mm. for all propellers absorbing less than 350 hp.

(5) Scarf and half-lapped joints to be allowed as in French propellers. The present (English) practice of using joints in two-bladers (apparently for variable pitch.—Editor) is dangerous and does not save material.

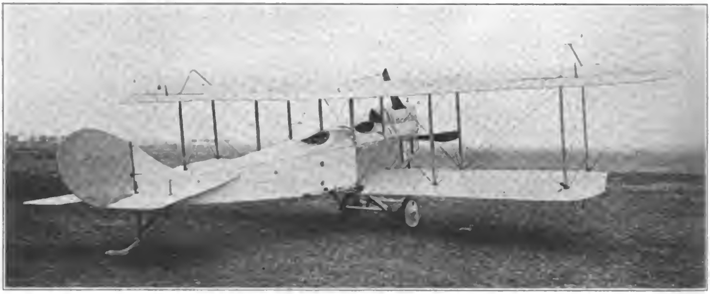
(6) Glueing up *en bloc*, which is used by some firms, to be generalized.

***Tohtli* (Mexico City), August, 1917**

Cross-country Flight of Mexican-built Airplane.—On July 6 a Mexican army biplane, piloted by Captain Horacio Ruiz, chief-pilot of the Valbuena Military aerodrome, made a cross-country flight from Pachuca, Hidalgo, to Mexico City.

Particular interest attaches to this flight because it was made by a Mexican-built airplane, the machine being a product of the National Aviation Works of Mexico City. The machine is a tractor biplane and it fitted with a 150 hp. Hispano-Suiza engine. During the flight, which lasted 58 min. 42 sec., an altitude of 1400 m. (4600 ft.) was reached. A mail bag containing 534 letters, 67 postal cards and second class mail was carried on the trip.

The Witteman-Lewis Training Tractor Airplane



The Witteman-Lewis Aircraft Co., of Newark, N. J., has recently produced a two-seater tractor biplane, called Model TT, which is specially designed as an advance training machine for military aviators.

The characteristics of the machine as given out by the manufacturer follow:

GENERAL SPECIFICATIONS OF MODEL TT

Span of upper plane	42 ft.
Span of lower plane	34 ft.
Overall length	27 ft. 2 in.
Overall height	9 ft. 8 in.
Chord of upper plane	5 ft. 6 in.
Chord of lower plane	5 ft. 6 in.
Curve of upper plane	W-L No. 7
Curve of lower plane	W-L No. 7
Gap	5 ft. 6 in.
Dihedral angle	1 deg. 30 min.
Area upper plane, exclusive of ailerons	223.21 sq. ft.
Area lower plane, exclusive of ailerons	206.8 sq. ft.
Area ailerons (2)	38 sq. ft.
Area horizontal empennage	51 sq. ft.
Area vertical empennage	17 sq. ft.
Span of empennage	10 sq. ft.
Area total supporting surface, inclusive of ailerons	392 sq. ft.
Loading per sq. ft	5.43 lb.
Loading per sq. ft	23.66 lb.
Weight of airplane, without power plant, fuel or load, but including main planes, body, fuel tanks, chassis, control and auxiliary surfaces	1040 lb.
Weight of power plant, including motor complete with radiator, cooling water, propeller, starting handle and other accessories but without gasoline or oil	490 lb.
Useful load, including pilot (165 lb.), observer (165 lb.), tools, parts, supplies, etc	360 lb.
Fuel load, gasoline and oil for four hours' flight at full power	240 lb.
Total gross weight	2130 lb.
Engine	Hall-Scott, A7a model
Horsepower	90 hp. at 1300 r.p.m.
Propeller	Walnut, Hall-Scott
Diameter	8 ft. 7 in.
Pitch	5 ft. 6 in.
Direction of rotation	Left hand
Control	Dep

Standard equipment: Fire extinguisher, tool kit, assortment of fittings and parts, propeller and cockpit covers, instruments as follows: Air speed meter, altimeter, clock, oil and air pressure gages, tachometer, thermometers, primer, shut-off valves, hand air pump and ignition switches and carburetors and magnetic throttles.

Aeronautical Patents

Copies of these patents may be obtained for five cents each by addressing the Commissioner of Patents, Washington, D. C.

ISSUED JULY 31, 1917.

1,234,727. Filed Oct. 9, 1916. To John W. Canrike, Coldwater, Mich Flying machine.

ISSUED AUGUST 7, 1917.

1,235,856. Filed Jan. 4, 1916. To Frank Ezra Summers, Memphis, Mo. Ornithopter.

1,235,988. Filed June 22, 1916. To Thomas R. Macmechen and Walter V. Kamp, New York, N. Y. Airship.

News of the Fortnight

Glenn L. Martin Organizes Company

Glenn L. Martin, the airplane pioneer of Los Angeles, Cal., and late vice-president of the Wright-Martin Aircraft Corporation of New York City, has just organized a company for the manufacture of aircraft at Cleveland, Ohio.

The company, it is announced, will have a capital stock of $2,500,000, all of one class, all shares to be sold at par value. There will be no bonus stock of any nature.

A number of prominent Cleveland business men are supporting the company.

Chas. E. Thompson, president of the Steel Products Company of Cleveland, Ohio, is to become president, and Mr. Glenn L. Martin will be vice-president, of the new company. The board of directors will be made up of S. L. Mather, C. W. Bingham, Chas. E. Thompson, W. G. Maher, Glenn L. Martin, Carl N. Osborne and Caleb S. Bragg.

Standardization Committee Meeting

The International Aircraft Standardization Committee met at the Bureau of Standards in Washington on August 21 and 22. Those attending the meeting were: Frank G. Diffin, United States, chairman; P. D. Merica, Bureau of Standards, U. S., secretary; Frithiof G. Ericson, Canada; Captain A. Pomilio and Dr. J. S. MacGregor, Italy; Dr. G. K. Burgess, Bureau of Standards, U. S.; George L. Norris, United States Signal Service; Lieut. M. Mignot and Captain Jean Herck, France; A. B. Rogers and S. G. Payne, England, and Captain D. E. Chanvalon, France.

Among the important matters announced as a result of this meeting is the statement that each Allied Government will appoint official representatives as permanent members of this committee. These representatives will designate members of their personal staff, appointing experts on the various subjects under consideration to attend the different meetings.

It is understood that the Committee will meet Thursday and Friday of each week at the Bureau of Standards, which is designated as the official headquarters.

It is reported that considerable work has been accomplished in standardizing the materials used in airplane construction, and it is anticipated that, with meetings scheduled for each week, announcements of the adopted standards will be forthcoming shortly and that official specifications will be available for distribution.

The meeting last week was devoted largely to steel specifications and the standardization of non-ferrous metals, particularly bronze, used in the manufacture of turn-buckle sleeves, bolts, and other parts, as well as aluminum for castings. All small accessories of this nature, which will be manufactured in large quantities and used to a great extent in all the airplanes of the Allies, are to be made uniform, so that they can be readily supplied or interchanged at a moment's notice.

Metal materials, samplings, analysis, instruction concerning physical tests of metals, selection tests, and methods of inspecting raw materials were considered. The Committee's specifications will be based largely on the practice standardized by the American Society for Testing Materials, which specifies standard methods for inspection of raw materials.

During the course of the meetings the subject of fabrics came up for a short discussion, specifications being considered, although this will not come up for a very full consideration until the next meeting, August 23 and 24. Under this division of the work, the material used for covering wings and rudders will be considered. Linen is, of course, almost universally used, but owing to the fact that linen of a suitable quality is not produced in this country, extensive tests and investigations are now under way to determine the production of a suitable cotton fabric which may be used for this purpose. The work on specifications for iron, steel, aluminum, brass, and bronze parts and fittings for airplane construction is well advanced, and it is expected that an announcement of the requirements will be forthcoming shortly. Meanwhile, preliminary standardization work is under way on other materials used in construction work.

P. D. Merica, of the Bureau of Standards, has been designated as the secretary of this committee.

The U. S. A. Engine Tests

Tests of the first of the standardized United States airplane engines designed and built under direction of the Aircraft Production Board make it practically certain that American-made fighting machines will be available for service in France early next year. Results from several tests have been highly satisfactory, it is learned, although details of the design and performance of the engines are withheld.

The first engine produced was employed exclusively as a model from which gages and fixtures could be made, so that numerous factories could be equipped to turn out in great quantities various parts of the engine. The progress of this element of the work indicates an early supply of the engines for service at the front.

Meanwhile the engineers are making every effort to improve the design and incorporate new features. As rapidly as improvements are developed they will be incorporated in subsequent engines, the same efforts toward quantity production being made each time the design is altered.

Aviation Supply Depot at Middletown

Laborers have started getting the 21-acre plot of the Keystone State Fair grounds near Middletown, Pa., into shape for the construction of a building 364 x 901 ft., to be used as an aviation supply depot. A 40-ft. runway will surround the entire building. Gannett, Seelye & Fleming, Harrisburg, Pa., engineers, in charge, estimate the cost of the work between $400,000 and $500,000.

The first building to be erected will be used as a supply depot for the assembling and distribution of air and water craft, wireless apparatus and machine-gun parts. This will be followed by the erection of an airplane and seaplane factory on adjacent ground.

China Seeks Aid in Training Army

China soon will seek the advice of the United States and the Entente Powers on the best way to cooperate in the war with Germany.

It had been believed that Japanese officers would have the task of training China's army, but it now appears that the United States, Great Britain and France, as well as Japan, are to be requested to send military experts to China.

Russia Needs American Aviators

General Zaliubovsky, president of the Russian Supply Committee in the United States, recently said:

"What we should like to see on the eastern front as soon as possible is 1,000 trained American aviators, with machines, and 1,000 ambulances. In these two branches of the service America's help will be of the greatest value.

Flying at Canal Zone

A temporary flying field has been established at a point in the Canal Zone where hangars and storehouses have been erected. The Canal Zone is not suitable to the operation of land machines, and it is almost impossible to find suitable landing fields. Captain Tussell is the acting department aeronautical officer, Canal Zone.

I. W. W. Menaces Airplane Work

It is feared the activities of the I. W. W. in the spruce producing regions of Oregon and Washington already have wrought serious damage to the Government's plans for the speedy construction of airplanes. Agents have found that injuries to the timber and to the machinery used in the fabrication of the wooden parts of the airplanes already has been accomplished.

The Administration's method of dealing with the I. W. W. will be an enactment, which is virtually an amendment to the existing espionage law, which provides punishment for persons engaged in seditious conspiracy to obtain breaches of contract with the United States.

Dayton-Wright Propeller Factory

The Dayton-Wright Airplane Co., Dayton, Ohio, has purchased the three-story plant of the Enterprise Carriage Co., at Miamisburg, Ohio, and will fit it up for the manufacture of propellers.

Huge Orders for Spruce Placed

Initial orders for airplane spruce aggregating 1,000,000 feet a month were placed in Portland, Ore., by the United States.

This business, as well as all subsequent airplane business to be placed here by the Government and the Allies, will be handled through the newly organized Spruce Lumber Manufacturing Bureau, which has been formed for the explicit purpose of co-ordinating all spruce deliveries to the allies.

The bureau has established headquarters in the Yeon Building, Portland, Ore., with F. A. Douty as chairman and J. P. Keating as secretary. All spruce mills in Oregon and Washington are members.

All the business will be placed by Mr. Allen, representing the allied governments, with this bureau and redistributed by the bureau among the member mills in proportion to the capacity of each individual plant.

The price has been fixed, tentatively, at $105 a 1,000 feet. This arrangement will be tried for a period of 30 days, and if satisfactory all around at the end of that time it is expected to be continued indefinitely.

New Curtiss Plant Will Be Ready Soon

The immense new plant of the Curtiss Aeroplane & Motor Corp. at Buffalo will be ready for business by October 15. Despite the fact that the land for the new plant was only secured a month ago, all of the foundations have been laid and two of the bays have been completed. Four miles of track, giving the company the very best of railroad connections, have been laid.

The new plant will occupy nearly 160 acres of land, and should increase the present capacity over 600 per cent.

Ford Is Making Cylinders

Henry Ford has announced that the Ford Motor Company is making 200,000 steel airplane cylinders for the Government, which are to be delivered at the rate of 1,000 per day.

"We have just developed a way of making these cylinders from solid steel, and they can be manufactured very cheaply," said Mr. Ford. "If called upon to do so, this output can be increased to 5,000, or even 10,000, a day. It costs very little more to produce steel now than it did before the war."

The matter of price has been left to the Government after the cylinders are completed.

To Start Work on Airplane Factory

The construction of the new $1,000,000 airplane factory at the League Island Navy Yard will be started at an early date.

Secretary of the Navy Daniels has awarded to the Austin Company, of Philadelphia, the contract for the erection of the building.

"Philadelphia will become the great building center for the Navy," Mr. Daniels stated. "Fully $15,000,000 has been or will be expended there in the next few months. There should be employment for 3,000 or 4,000 men."

The building will be of steel and brick construction, 400 ft. square, and will be finished within the next three months.

Lawson Aircraft Corp. Elects Officers

The Lawson Aircraft Corp., Green Bay, Wis., organized with a capital stock of $200,000 to manufacture airplanes, has elected the following officers: President, George W. Ellis; vice-president and general manager, Alfred W. Lawson; secretary, C. I. Smith; treasurer, George A. Richardson; counsel, Max H. Strehlow; directors, William Hoberg, F. E. Burrall and Messrs. Ellis, Lawson and Richardson.

Standard Aero Corp. Expands

The Standard Aero Corp., of Plainfield, N. J., announces the purchase of the J. G. Brill Car Works in Elizabeth, N. J., for the manufacture of airplanes. The property represents a cost of $750,000, and it is estimated that, including equipment, the total cost of the establishment, before beginning operation, will amount to $1,000,000.

The growth of the Standard Aero Corp. has been one of the remarkable features of the American aircraft industry. The important factor in the building up of this firm has been its personnel, which includes some of the best brains of the aircraft industry.

Charles H. Day, the chief engineer and designer, is one of the pioneers of American aviation. He built the first tractor biplane in this country and also the rotary engine which propelled it. After having successfully flown this machine, he became associated with the Glenn L. Martin Co., of Los Angeles, Cal., in the capacity of chief engineer. After having severed his connection, he built a number of his own machines, but returned to the Glenn L. Martin Co. in 1913, where he remained until 1914, when he joined the Sloane Manufacturing Co., which eventually became the Standard Aero Corp. In his latter connection he built the well known H-3, J, J-H, and speed scout type standard airplanes.

Harry Bowers Mimgle, president, is in charge of the operations of the corporation and is its sole stockholder. To him is largely due the growth of this organization.

Loening Aeronautical Engineering Corp.

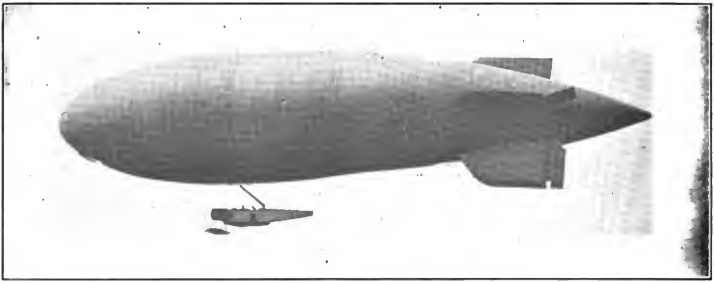
The Loening Aeronautical Engineering Cor., New York, has been incorporated with a capital of $25,000, to manufacture aircraft. G. C. and R. R. Loening and T. C. Curtis, 44 Wall Street, are the incorporators.

Boeing Airplane Co. Plans Extensions

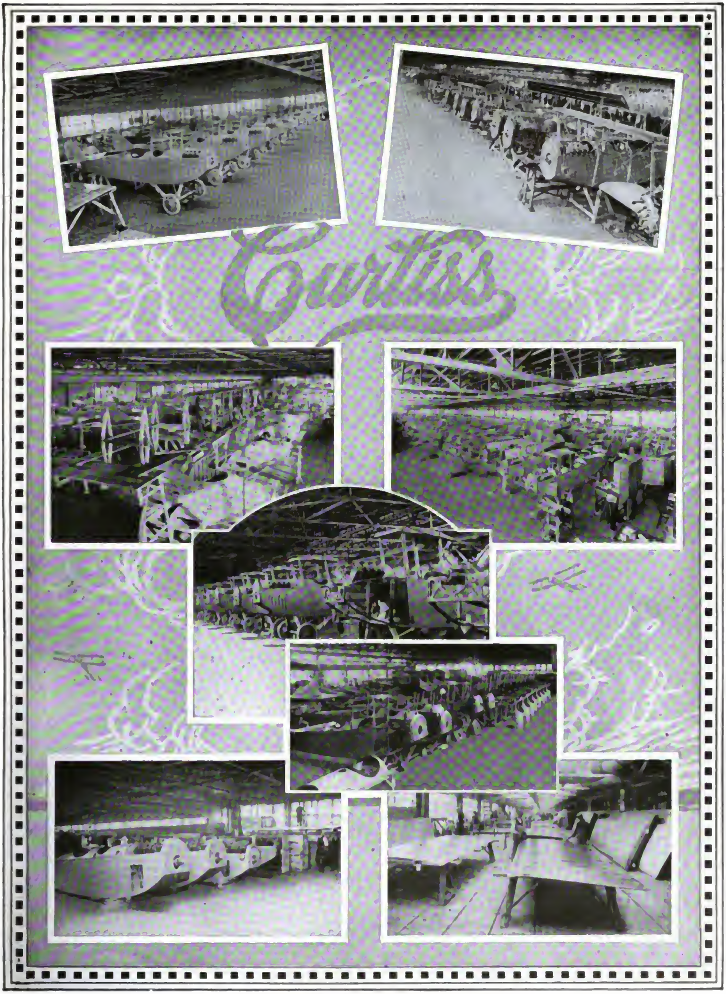
The W. E. Boeing Airplane Co., Hoge Building, Seattle, Wash., contemplates extensions and improvements to its factory on Lake Union.

Hydrerocraft Co. Organized

The Hydrerocraft Co. has been incorporated in New York with a capital of $30,000 by L. W. E. Coleman, C. L. Andrews and H. P. Keane. A flying field has been leased at Central Park, Hempstead Turnpike, L. I., and the company will give instruction in flying, photography, etc., to men above the age limit of the army, with a view of getting them to become observers.



An American "Blimp"



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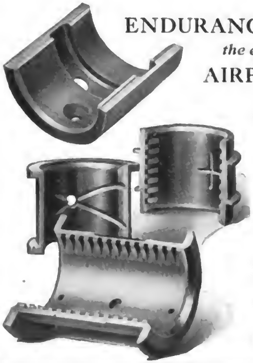

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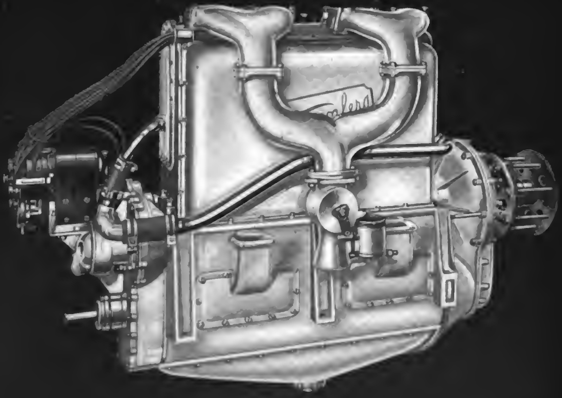

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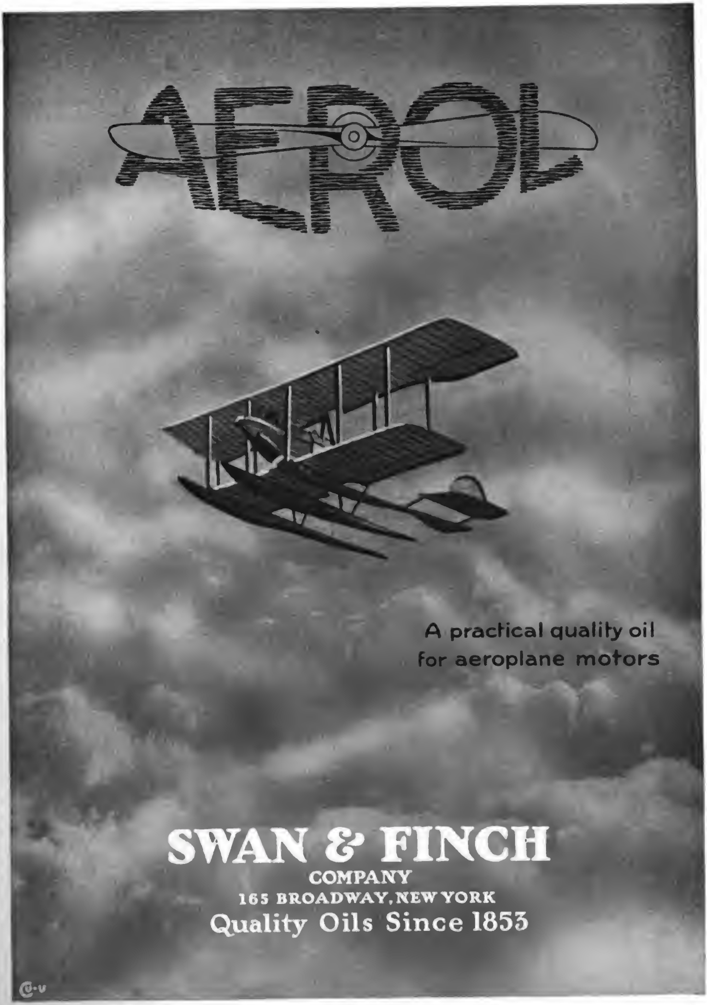
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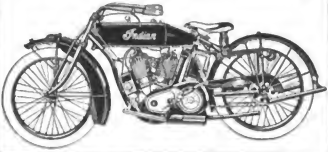

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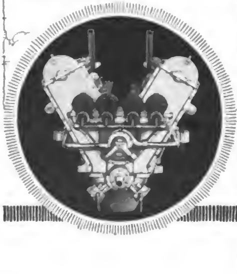

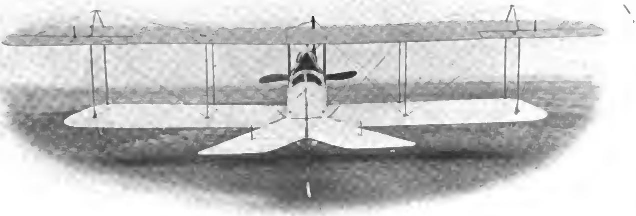

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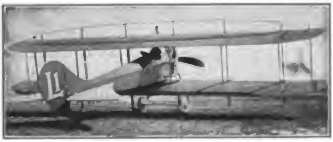

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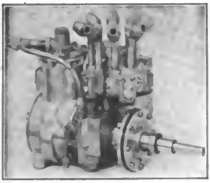

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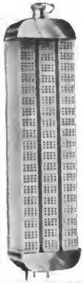

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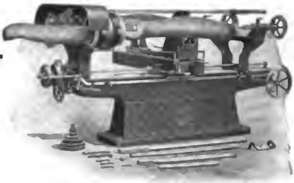

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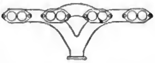

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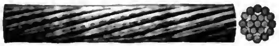

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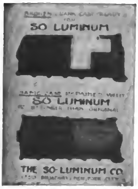

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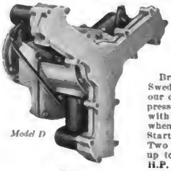

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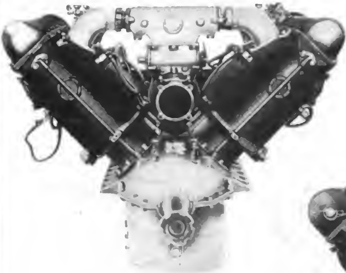

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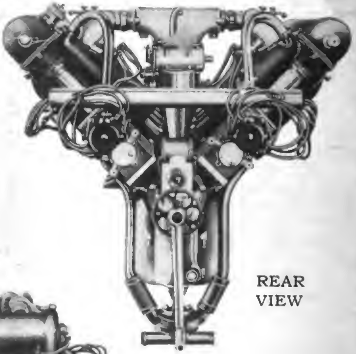
DEVELOPS 150 H. P.
AT 1450 R. P. M.



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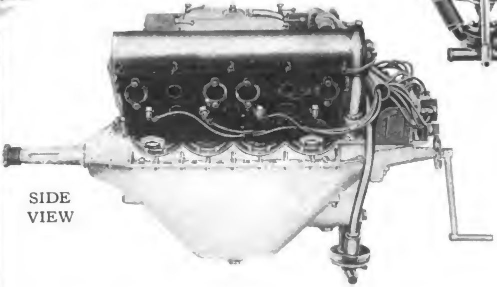

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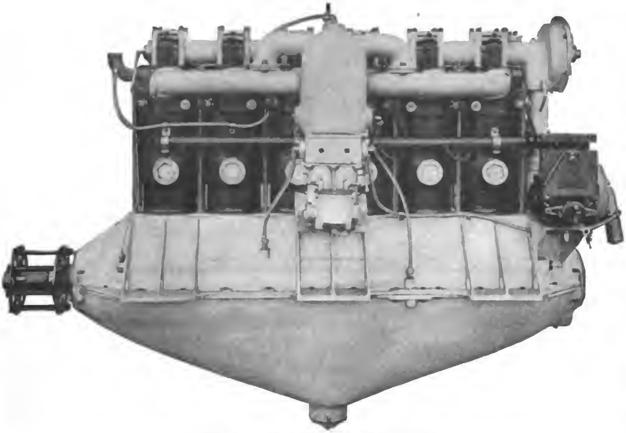

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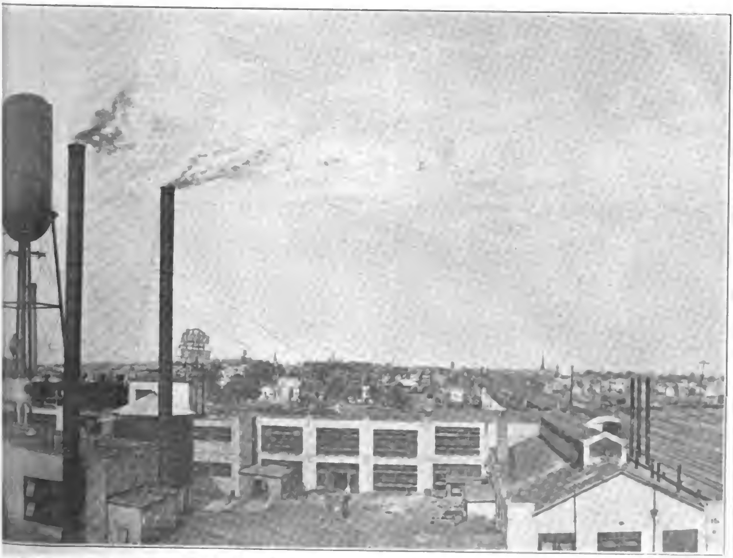

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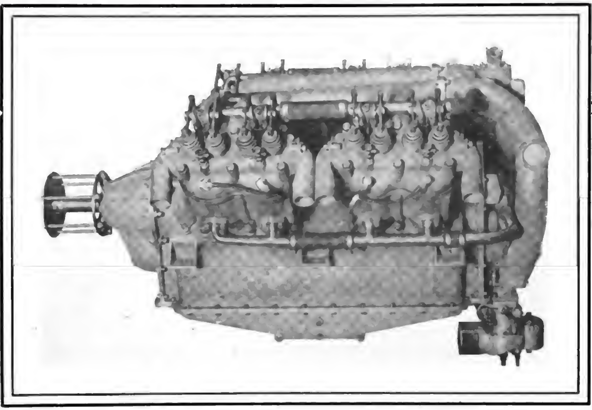

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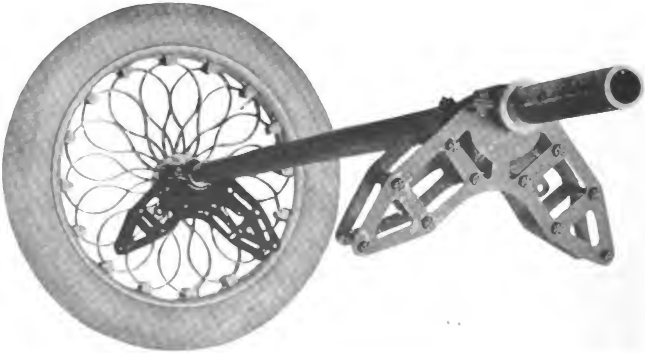

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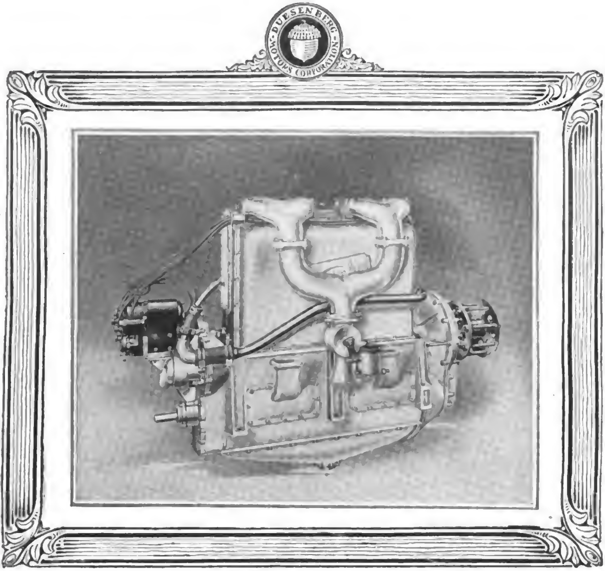

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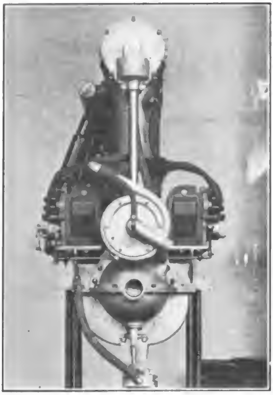

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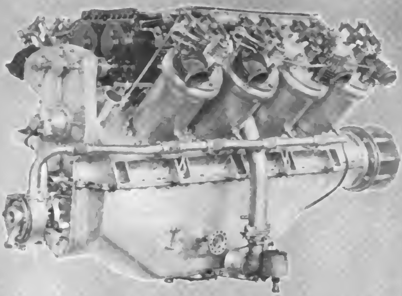

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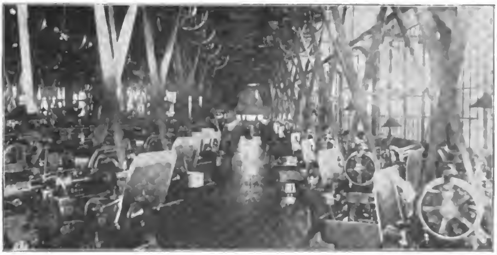

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SEPTEMBER 15, 1917

AVIATION
AND
AERONAUTICAL ENGINEERING

VOL. III. NO. 4

Member of the Associated Business Papers, Inc.

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AVIATION
AND
AERONAUTICAL ENGINEERING

Vol. III September 15, 1917 No. 4

THE influence of war on a publication such as Aviation and Aeronautical Engineering is so overwhelming that a clear statement regarding the novel conditions brought about is, in all fairness, due to its readers. In order that they may understand the difficulties under which editorial matter of worth is secured, edited and censored, attention is directed to the following facts:

In the first place four officers of the company, namely the former President, Treasurer, Secretary and Military Editor are all in active military service. The President, Lester D. Gardner, is a Captain in the Aviation Section of the Signal Corps of the Regular Army; the Treasurer, William I. Seaman, is a member of the Veteran Corps of Artillery, which is on active duty guarding the water supply of New York; the Secretary, Joseph H. Coit, is a Captain in the Quartermaster's Corps, in charge of a transport for troops; the Military Editor, Philip J. Roosevelt, is a Captain in the Aviation Section of the Signal Corps of the Regular Army. The above named officers in Federal service have naturally resigned from the company and will have no connection with it for the duration of the war.

It is, however, very fortunate that the editorial staff which has directed the policy of Aviation and Aeronautical Engineering from the very beginning will continue its policies, so that, barring a few exceptions, there will be no noticeable changes.

The most important of these, however, will be the disappearance of the editorial page with the next issue. To be worthy of its readers' confidence, a policy of conservative and constructive criticism must underlie all editorial comment. With so many officers of the company in the services it would be extremely difficult to maintain an unbiased view of aeronautical progress.

Another reason which prompted the discontinuance of editorial comment is the strict censorship that is being exercised on all aeronautical information. Orders have been issued by the War Department to the effect that virtually all articles relating to engineering or construction must be submitted before publication. It may interest our readers to know that all articles and illustrations appearing in this magazine conform to the strict requirements of the censorship.

After the war, when, it is hoped, the officers who left the company to serve their country may return, it seems likely that the expression of editorial opinion will be resumed. But in these times, when all good citizens should be doing their utmost to secure for us and our Allies victory in the air, opinions not fully conversant with prohibited information would prove of no constructive value.

The Liberty Engine

The unanimous commendation greeting the appearance of the Liberty engine is well merited. Messrs. Hall and Vincent in particular deserve praise of the highest order for their achievement. Not only has a brilliant feat of engineering been brought to a satisfactory conclusion, but many phases pertaining to the design and construction of this engine were dramatic in the extreme. The story of how the Government's call for assistance was met by draftsmen as well as by manufacturers will have to wait for a time before it may see publicity, but there is no question that it represents a feat unequalled heretofore.

The Secretary of War's official statement recounting how the Liberty engine was conceived and executed furnishes most inspiring reading. Here we have the proof that, given the possibility of developing an engine under conditions paralleling those prevailing abroad, American engineers can design and build an aero engine equal to the best of those produced in Europe. What is more, this engine, which was produced in less time than it would have taken to bring a European model over here, is particularly suited for American manufacturing conditions.

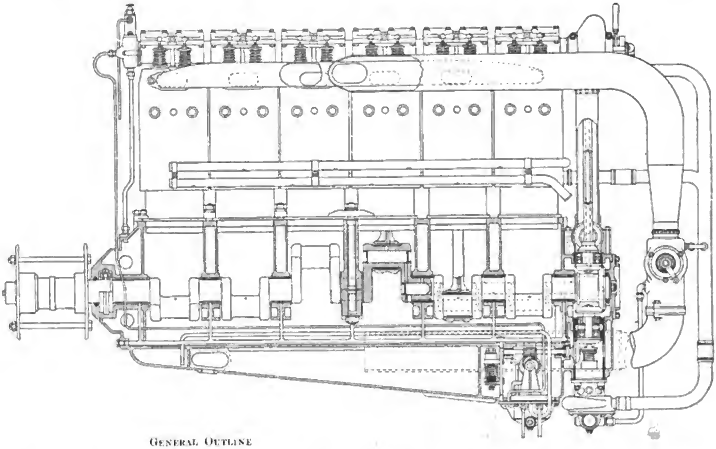
There is, however, behind this marvel of American ingenuity a certain ancestral influence which the popular accounts appearing in the daily press have failed to emphasize. The manufacturers of American aero engines, who have, in the past, made considerable investments amid little official encouragement in order to develop a satisfactory aero engine of national make, share in no mean way the responsibility for the success of the new engine.

They have placed not only their experience and their designs at the disposal of the Government, permitting the latter to embody in the Liberty engine such features as represent the best present-day practice, but they have also loaned their engineers to the Government so that their experience might result in a permanent achievement. It is this admirable voluntary cooperation between the aircraft industry and the Government which has chiefly been instrumental in making a success of the Liberty engine, and it is to be hoped that the intimate understanding thus established between the two parties concerned will have created a happy and fruitful precedent, which should largely influence the carrying out of America's air program.

The 260 Horsepower Mercedes Aero-Engine*

The 260 hp. Mercedes aero-engine herewith described is typical of German ideas at the moment, and resembles in general design and even in minor details the well known 150 and 175 hp. models of the same manufacturers.

The complete engine, including the propeller boss, measures 6 ft. 5½ in. over all, and from the bottom of the sump to the top of the overhead camshaft casing measures approximately 3 ft. 10 in. The bore of the cylinders is 160 mm. (6.2992 in.) and the stroke 180 mm. (7.0866 in.). The engine is of the vertical, water-cooled type with six independent steel cylinders, each cylinder carrying in the head two inlet and two exhaust valves which are operated by an overhead camshaft running in a separate housing. The valves are interchangeable. The well-known four-throw eccentric driven plunger pump and the half-compression gear of the 160 hp. model have been retained with slight alterations. Forced lubrication is employed. Two Bosch Z.H.-6 high tension magnetos are fitted.



GENERAL OUTLINE

Cylinders.—The cylinders are built up entirely of steel machined all over, with autogenously welded steel sheet water jackets. The cylinder barrels are screwed into the cylinder head and are machined from forgings or billets. The cylinder walls taper in section from 3.5 mm. at the top to 6 mm. at the base flange. Six stiffening ribs are machined on the cylinder, the distance between the ribs increasing towards the base. The barrels extend 35 mm. below the base flanges and are of 3 mm. thickness for the depth of 12 mm., forming the register, the extension being then reduced to 2.75 mm.

The cylinder heads are steel forgings, the thickness of the crown being 11 mm. The valve seats are machined in the cylinder heads, while the valve pockets are machined from steel forgings autogenously welded to the cylinder heads.

The water jackets are built up in four sections from sheet steel pressings of 1.25 mm. thickness, their lower portion being welded to the flange joint on the cylinder walls. The upper portion surrounds the valve pockets. The spark plug bosses are welded into the cylinder barrels on the induction side, just below the inlet valves. The complete cylinder, with valves and valve springs, and including the two brackets supporting the camshaft housing, weighs 34.25 lb.

Pistons.—The pistons are built up in two halves. A steel forging machined all over forms the head, the thickness of the crown being 8.5 mm. The skirt of the piston is made of cast iron and is screwed on to the head, the joints being autogenously welded. Three compression rings are fitted; these are 5 mm. wide and split at 45 deg. The gudgeon pin is 37 mm. in diameter and is fixed by an 8 mm. set screw. The weight of the piston, complete with pin and bush, is 11 lb.

Valves.—The maximum diameter of the head of all valves is 60 mm., while the port diameter is 55.25 mm. The lift of both inlet and exhaust valves is 10 mm.

The valves are operated by a single overhead camshaft, enclosed in a housing of special alloy which is supported on T brackets screwed into the cylinder heads.

The diameter of the valve stems is 11 mm. All valves are set at an angle of 15 deg. to the cylinder center line. Single helical valve springs are fitted. They measure 39 mm. at the base of the coil, and taper to 31 mm. at the top.

Camshaft Drive.—The camshaft is driven through a vertical shaft by the main distribution bevel pinion mounted on the end of the crankshaft.

Decompression Gear.—To effect half compression the camshaft is designed to slide longitudinally in its bearings and bring into operation a small cam situated on the mid-neutral axis of the exhaust cam proper. The camshaft is made to slide by a hand lever to which is attached a collar located in an aluminum housing at the driving end of the camshaft. This collar engages with a screw thread cut on the outer diameter of a steel sleeve containing a double ball thrust. In operation the rotation of the hand lever acts on the quick thread screw in the sleeve, thus displacing the end of the camshaft in its bearings through castellations fitted to the driving bevel gear. When drawn to its rear limit, the decompression cam is engaged with the roller end of the exhaust valve rocker arm, giving the required lift to the exhaust valves.

Connecting Rods.—These are steel forgings of H-section

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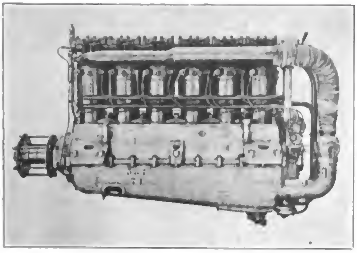
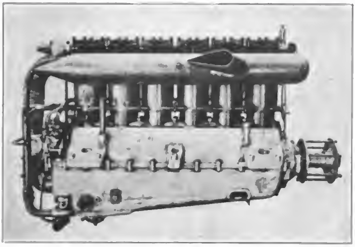
* Abstract from *The Automobile Engineer* (London).



INDUCTION SIDE



EXHAUST SIDE

and measure 326 mm. between centers. The total weight is 7 lb. The distinctive feature of the connecting rods is the floating gudgeon pin bush, which is of hardened steel, and is running fit in the small end and also on the gudgeon pin. It is pierced by fourteen 5 mm. holes, to which oil is supplied by a 6 mm. pipe leading from the big end bearing.

Crankshaft.—The crankshaft is of the six-throw type, running on plain bearings, and weighs 139.5 lb., including the propeller boss.

The crankshaft is hollowed out and provided with webs for passage of the lubricating oil. A ball thrust washer of 110 mm. diameter is provided on the front bearing to take the propeller thrust. The propeller boss is mounted on a taper on the crankshaft; the propeller is secured to the boss by six 18 mm. bolts.

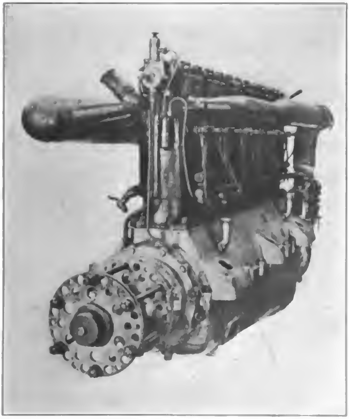
Crankcase.—The crankcase is of conventional design, the top and bottom halves being held together by twenty-six 10 mm. hollow bolts. The crankshaft main bearing caps are cast with the bottom half, and the long 20 mm. bolts, securing them at the bottom, pass through the top half and act as holders for the cylinders.

The main oil sump is located in the rear end of the crank chamber and contains the main oil pump; in the front end there is an auxiliary sump in which the return oil is drained by means of a wire gauze filter. Between the two sumps an air chamber is provided for the purpose of cooling the oil and warming the air supplied to the carburetor.

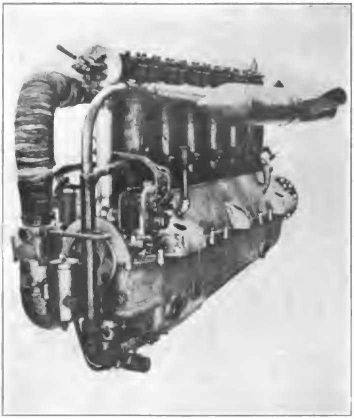
Lubrication.—Forced lubrication is employed. This is effected by means of two main plungers; three auxiliary plungers are suspended from one of the main plungers, and these work in conjunction with piston valve plungers at the sides of the main pump. Each pump and plunger is operated by an eccentric driven by a worm gear from a layshaft at a 17 to 1 ratio to engine speed. The layshaft is driven by bevel gearing from the vertical driving shaft of the water pump, the latter being actuated from the main bevel gear at the rear of the crankshaft.

The lubrication system may be subdivided into three circuits, namely:

(*a*) The main pressure circuit, in which oil is drawn from the main oil sump at the rear of the engine and forced to the crankshaft, connecting rods, camshaft bearings, etc.



PROPELLER END

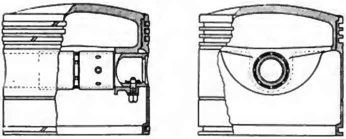


ANTI-PROPELLER END

(*b*) The supplementary pressure system that works in conjunction with the main high pressure system, in which two auxiliary plungers of the main oil pump draw a small charge of fresh oil from the service oil tank at every stroke, and thus keep the main circulation supplied with a certain quantity of fresh oil.

VALVES AND CAMSHAFT

(*c*) A suction scavenging circuit, which supplies the main oil sump from the auxiliary drain sump at the front of the base chamber, the working oil level being maintained in the rear sump by a secondary suction pump that draws off the oil above the oil level through an overflow pipe and returns it to the service oil tank.



THE PISTON

In the main pressure system the functioning of the oil pump is the following: Oil is drawn from the main sump through a wire gauze filter by the suction of the main plunger pump *A* through the port *B* in conjunction with the piston valve *C*, when the latter is in the open position with the port *B*.

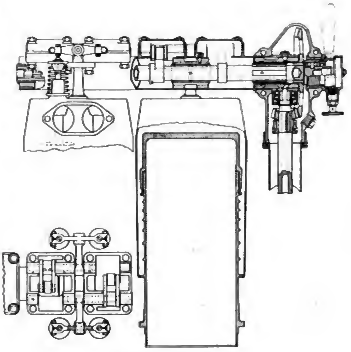
On the downward stroke of the main plunger *A*, the oil is forced through the port *B* and the annular space above the piston valve *C*, through the main delivery pipe *D*, to the main bearings, when the piston valve *C* has uncovered the port *B* on its downward stroke.

Simultaneously the auxiliary plunger *E*, which is fitted to the bottom of the plunger *A*, draws a charge of fresh oil on its upward stroke. This charge is taken through a port in the bottom end of the valve plunger from the oil service tank through the pipe *G*, and on the downward stroke of the plunge pump *E*; the charge of oil is forced upward through the hollow valve plunger through the port *H*, and through a hole in the stem of the plunger, which communicates with the main oil delivery pipe *D* to the main bearings.

At the same time the twin plunger *E*, draws fresh oil from the service tank and forces the charge to the camshaft bearings through the pipe *J*, the oil entering the front end of the camshaft through the hollow spindle of the air-pump, which is attached to the front end of the camshaft casing. In its passage through the hollow camshaft the oil under pressure is fed through small holes and oil grooves cut in each of the camshaft bearings.

The camshaft rocker arm spindles are lubricated by oil thrown off the revolving cams, which deliver oil into two holes drilled in the upper portion of the rocker arm spindles. These holes communicate with the bearings by small holes drilled radially in the spindle.

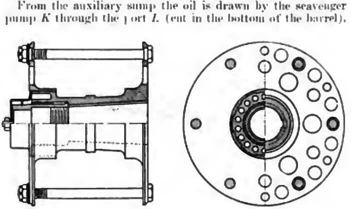
No outlet holes are provided in the rear end of the camshaft for the egress of the oil; consequently, the camshaft is under constant oil pressure, which finds its way through the bearings into the troughs in the bottom of the camshaft housing. The overflow oil returns to the crankcase through the air pump, escaping therefrom at the bottom by a 12 mm. pipe running down to the front end of the engine. At the rear end of the camshaft casing oil escapes down the hollow, vertical shaft, oil channels being cut in the underside of each of the camshaft bearing bushes for the purpose.



DECOMPRESSION GEAR

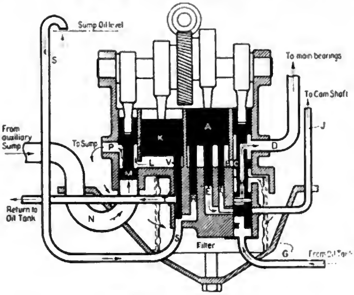
The oil that has thus returned by gravity to the crankcase is led into the oil sump at the rear through two holes of 30 mm. diameter, drilled in the false bottom of the base. At the forward end of the crankchamber, the oil flows into the auxiliary sump through a wire gauze filter already referred to.

From the auxiliary sump the oil is drawn by the scavenger pump *K* through the port *L* (cut in the bottom of the barrel), the piston valve *M* being in its upward position. The oil, therefore, enters the pump through the large suction pipe *N*, and is discharged on the downward stroke of the pump plunger *K* into the sump through the port *P*, drilled in the side of the piston valve barrel.



PROPELLER BOSS

To maintain the correct working oil level in the sump, a third plunger *R*, also attached to the bottom of the main plunger pump *A*, draws off, through the suction pipe *S*, any surplus oil above the working level in the sump, and returns it to the oil service tank through the pipe *T*. On the downward stroke of the plunger *R*, the latter works in conjunction with the piston valve *V*, which is flexibly attached to the bottom of the suction pump *K*, in a slot cut in the face of the pump. In the main pressure delivery pipe to the crankshaft bearings, and directly above the oil pump, a pulsation damper valve is located.



CROSS-SECTION OF OIL PUMP

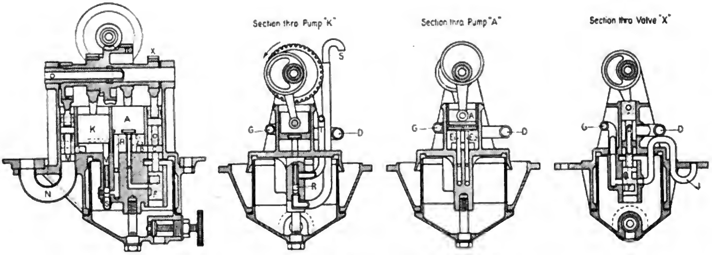
In operation, the pulsations of the oil pump plungers are damped out in the delivery pipe by the cushioning effect of the spring-loaded plunger, which communicates direct with the pump on its underside. The bottom face of the plunger is prevented from reaching the bottom of the barrel by a small set-screw in the base.

The lubrication of the crankshaft and connecting-rod bearings is on standard lines; details of this are shown in the general outline of the engine.

Induction.—Induction is effected by one carburetor only, which is situated at the after end of the crankshaft. The float chamber of the carburetor is fitted on the bottom with a filter chamber, the gasoline being led through a wire gauze filter.

Ignition.—Ignition is effected by two Bosch high-tensioned magnetos, which are mounted at the rear end of the crankcase, one being a starter magneto used in conjunction with a hand starter dynamo. All twelve spark plugs are fitted below the inlet valves, the high-tension wire being carried in fiber tubes.

Water Pump.—The water pump is of the centrifugal type and is driven by a vertical shaft through a bevel gear on the end of the crankshaft. The pump is mounted on a flange on the bottom of the sump, next to the oil pump. Double inlet water connections between each of the six cylinders supply the water jackets at the top and bottom.



DETAILS OF OIL PUMP

Aeronautical Patents

ISSUED AUGUST 14, 1917

1,236,493. To Howard J. Smiley, Canton, Ohio. Launching and Landing Device.

1,236,603. To John J. Reynolds and Arthur H. Jenkins, Ruleville, Miss. Dirigible-Balloon Construction.

1,236,961. To Thomas Rutherford MacMechen and Walter V. Kamp, New York, N. Y. Airship.

1,236,741. To Harrison R. Morris, Mapleton, Kans. Flying Machine.

1,237,039. To Willoughby A. Henley, Altus, Okla. Airplane.

1,237,072. To William H. McMullen, Whitestone, N. Y. Steering or Stabilizing Device for Airplanes.

1,237,206. To Lewis Nixon, New York, N. Y. Incendiary Attachment for Airplanes.

ISSUED AUGUST 21, 1917

1,237,318. Filed Oct. 19, 1916. To John Flink, Philadelphia, Pa. Airship.

1,237,364. Filed June 10, 1914. To Henry Miller, Cicero, Ill. Flying Machine.

1,237,715. Filed May 29, 1916. To James F. Smith, Los Angeles, Cal. Adjustable Water-Planing Surface.

1,237,734. Filed May 17, 1915. To Rushmore Wood. Standard of Position for Aircraft.

1,237,772. Filed Mar. 10, 1917. To Robert E. Friederick, Rogers, Mich. Flying Machine.

1,237,789. Filed Aug. 5, 1912. To William H. Kelly, Cheyenne, Wyo. Flying Machine.

1,237,888. Filed Oct. 14, 1916. To Alphonse Fernandez, Washington, D. C. Airship.

1,237,889. Filed Oct. 14, 1916. To Alphonse Fernandez, Washington, D. C. Airship-Engine Release.

1,237,890. Filed Oct. 14, 1916. To Alphonse Fernandez, Washington, D. C. Bomb-Dropping Mechanism.

1,238,031. Filed Mar. 28, 1912. To Ladis Lewkowicz, New York, N. Y. Aeronautical Apparatus.

ISSUED AUGUST 28, 1917

1,234,264. Filed July 27, 1916. To Jan Chodakowski, Binghamton, N. Y.

1,234,315. Filed Sept. 25, 1916. To Thomas Rutherford Macmechen and Walter V. Kamp, New York, N. Y. Airship.

1,234,316. Filed Oct. 7, 1916. To Thomas Rutherford Macmechen and Walter V. Kamp, New York, N. Y. Airship.

1,234,451. Filed Jan. 4, 1917. To Ernest L. Sons, Pittsburgh, Pa., assignor of one-half to S. A. Boyd, Pittsburgh, Pa. Airship.

1,234,572. Filed Sept. 27, 1916. To Elmer L. Russell, Great Falls, Mont. Aeroplane.

ISSUED SEPTEMBER 4, 1917

1,239,041. Filed Sept. 19, 1916. To Verdon Roe, Manchester, Eng. Belt Support for Aviators.

1,239,907. Filed Mar. 25, 1915. To Charles E. Gordon, Marlborough, Mass. Aerohydro ship.

1,239,904. Filed Apr. 5, 1917. To William F. Folmer, Rochester, N. Y., assigned to Eastman Kodak Co., Rochester, N. Y. Aerial Carrier for Photographic Films.

1,238,839. Filed Nov. 25, 1916. To Thomas B. Slate, Washington, D. C., assignor to American Mechanical Improvement Co., Washington, D. C. Aero-Vehicle Body.

Vibrations of a Rotating Air-Screw and Its Shaft*

By A. Fage, A.R.C.Sc.

The present paper gives the mathematical theory of the transverse vibrations of a rotating air-screw and its shaft, and also an application of the method to several practical problems. For generality, the calculations have been made for a two-bladed air-screw when the transverse vibrations are in a plane parallel to both the axis of the air-screw blades and the axis of rotation, and also when in a plane at right angles to the axis of the air-screw blades and parallel to the axis of rotation. The dependence of the frequency of the transverse vibrations on the length of the shaft, and also on the speed of rotation, has also been determined. Finally, by the elimination of quantities which only slightly influence the value of the frequency of the transverse vibrations, a moderately accurate working formula has been evolved, from which the whirling speed of a rotating air-screw and shaft may be readily calculated. The whirling speed of a modern air-screw as now mounted on the engine of an airplane is very high and very much greater than the bursting speed of the air screw. The mathematical theory of the transverse vibrations of rotating systems is given by Dr. Chree in the Proceedings of the Physical Society of London (1903-5).

In order that the present paper may be complete it is desirable at the outset to indicate the relationship between the frequency of the lateral transverse vibrations and the whirling speed. Taking the simple case of a shaft of negligible mass, fixed at one end and carry a mass M at the other, it can easily be shown, if $\frac{p}{2\pi}$ be the frequency of the transverse vibrations of the mass M when the shaft is not rotating, and $\frac{q}{2\pi}$ the frequency of the transverse vibrations when the shaft is rotating with an angular velocity ω, that $q^2 = p^2 - \omega^2$.

The elastic forces of the shaft tend to restore the mass to its equilibrium position, but the centrifugal force acting on the mass has the opposite tendency, and by reducing the magnitude of the righting force diminishes also the frequency of vibration of the rotating mass and shaft. If ω be equal to p, the frequency of the transverse vibrations is zero, so that the mass is in neutral equilibrium no matter what the value of the lateral displacement may be, and hence if the lateral displacement be sufficiently great the shaft will fracture. A shaft in such a state is said "to whirl," the righting force due to the elasticity of the system having been reduced to zero by the centrifugal force called into being by deflection. For this particular instance the frequency of rotation when the shaft is whirling, and the frequency of the transverse vibrations when the shaft it not rotating, have equal values, but this is not the case with a rotating air-screw and shaft in which moments of inertia and damping need consideration.

To Find the Frequency of the Transverse Vibrations of Rotating Air-Screw and Shaft

The following investigation is an application of Lagrange's equations for small oscillations.

An instantaneous position of the rotating and vibrating air-screw and shaft is shown in Fig. 1, the plane of vibration of the shaft being coincident with the plane of the paper. It is assumed that the air-screw shaft is fixed in direction at the end O, so that the line OX represents the mean position of the vibrating shaft, and also the axis about which the rotation is taking place.

The following symbols are used in the investigation:

L = Length of the shaft in feet.
M = Mass of the air-screw in slugs.
m = Mass of the shaft in slugs per ft. run.
I_1 = Moment of inertia of the air-screw about the axis CA in slug-ft.².
I_2 = Moment of inertia of the air-screw about an axis through C at right angles to the plane of bending.
I_3 = Moment of inertia of the air-screw about an axis through C in the plane of bending and at right angles to CA.
ω = Speed of rotation of the air-screw in radians per second.
E = Young's modulus of elasticity in pounds per square foot.
I = Moment of inertia of a cross-section of the shaft about a diameter measured in ft.⁴.
x = Distance from O, in feet, of any point P on the axis of the shaft.
y = Deflection, in feet, of the point P from the line OX.

At any time t the free end of the shaft is displaced a distance z from its mean position, and the plane of the air-screw has an angular displacement θ from its mean position.

The equations of motion are expressed in terms of the variables θ and z.

From the above remarks it follows that when

$$x = 0,\ \frac{dy}{dx} = 0 \text{ and } y = 0,$$

when

$$x = L,\ \frac{dy}{dx} = \theta \text{ and } y = z.$$

So that the equation of the curve of the center line of the shaft is

$$y = \left(\frac{3z - \theta L}{L^2}\right)x^2 + \left(\frac{\theta L - 2z}{L^3}\right)x^3.$$

Lagrange's equations for a damped vibrating system in which there are two variables, θ and z, are

$$\frac{\delta}{\delta t}\left(\frac{\delta T}{\delta \dot\theta}\right) - \frac{\delta T}{\delta \theta} + \frac{\delta V}{\delta \theta} + \frac{\delta F}{\delta \dot\theta} = 0$$

and

$$\frac{\delta}{\delta t}\left(\frac{\delta T}{\delta \dot z}\right) - \frac{\delta T}{\delta z} + \frac{\delta V}{\delta z} + \frac{\delta F}{\delta \dot z} = 0$$

where T = kinetic energy of the whole system,
V = potential energy of the whole system,
and F = half the rate at which energy is being dissipated.

For the case of a vibrating air-screw and shaft the kinetic energy of the whole system is equal to the kinetic energy of the shaft + the kinetic energy of the air-screw.

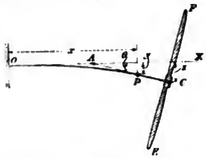


Fig. 1. Diagrammatic Sketch of the Vibrating Airscrew Plane of Vibration Coincident with Plane of Paper
EF-Axis of Airscrew Blades

$$= \int_0^L \frac{1}{2} m\,dx\left[\dot y^2 + (y\omega)^2\right] + \frac{M}{2}\left(\dot z^2 + \omega^2 z^2\right) +$$

$$\frac{I_1}{2}\omega^2\cos^2\theta + \frac{I_2}{2}\omega^2\sin^2\theta + \frac{I_3}{2}\dot\theta^2.$$

$$= \left\{\begin{array}{l} \frac{m\omega^2 L}{2}\left[\frac{1}{5}(3z - \theta L)^2 + \frac{1}{3}(3z - \theta L)(\theta L - 2z) + \frac{1}{7}(\theta L - 2z)^2\right] \\ + \frac{mL}{2}\left[\frac{1}{5}(3\dot z - \dot\theta L)^2 + \frac{1}{3}(3\dot z - \dot\theta L)(\dot\theta L - 2\dot z) + \frac{1}{7}(\dot\theta L - 2\dot z)^2\right] \\ + \frac{M}{2}(\dot z^2 + \omega^2 z^2) + \frac{I_1\omega^2}{2} + \frac{I_3}{2}(\dot\theta^2 - \omega^2\theta^2) \end{array}\right\}$$

since $I_1 = I_2 + I_3$ and $\sin\theta = \theta$ nearly.

The potential energy, V, of the system is equal to the potential energy of the shaft =

$$\int_0^L \frac{EI}{2}\left(\frac{d^2y}{dx^2}\right)^2 dx.$$

$$= \int_0^L \frac{EI}{2}\left[\frac{2}{L^2}(3z - \theta L) + \frac{6x}{L^3}(\theta L - 2z)\right]^2 dx$$

$$= \frac{2EI}{L^3}\left[3z^2 - 3z\,\theta L + \theta^2 L^2\right]$$

Owing to the vibratory motion of the air-screw blades through the air, energy is dissipated, the rate of such dissipation—$2F$—being equal to $K\dot\theta^2$, where K is a constant. The value of the damping factor K can be readily calculated when the aerodynamical data of the blade sections of the air-screw and also the working conditions of the air-screw are known, but it may be of some interest to explain in general language why the rate at which energy is dissipated is proportional to the square of the angular speed of vibration.

Consider the vibratory motion of the blades about an axis through C (Fig. 1) at right angles to the axes of the air-screw and of the air-screw blades, the air-screw having the forward translational speed of the airplane, and a rotational speed about the axis $O\ X$ of ω radians per second. For any positive value of the angular velocity $\dot{\theta}$, the thrust on the blade $C\ F$, which is moving into the air with a velocity greater than that due to the motion of the airplane alone, is diminished, while the thrust on the blade $C\ E$ is increased, the change of thrust of an aerofoil section of the blade being roughly proportional to the change of angle of incidence of the section relatively to the air. As a first approximation the change of the angle of incidence of a blade section is proportional to $\dot{\theta}$, so that the change of thrust of the blade and therefore also the damping moment on the air-screw is proportional to $\dot{\theta}$. Writing the damping moment as $K\ \dot{\theta}$ the rate at which energy is dissipated becomes $K\ \dot{\theta}^2$. It will be shown later that the damping moment does not appreciably influence the frequency of the transverse vibrations. Hence

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* From *Engineering* (London).

$$F = \frac{K\ \dot{\theta}^2}{2}$$

where K is a constant.

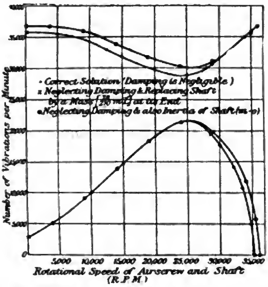


FIG. 2. TRANSVERSE VIBRATION IN A PLANE PARALLEL TO THE AXIS OF ROTATION & TO THE BLADE-AXIS. L-0-5 FT. L-3-5 SLUG-(FT.)$_2$

Substituting the above values of T, V and F in the Lagrangean equations we get:

$$I_2\ddot{\theta} + \frac{m\ L^3}{210}\left(2\ L\ \ddot{\theta} - 11\ddot{z}\right) - \frac{m\ \omega^2\ L^3}{210}\left(2\ L\ \theta - 11\ z\right) +$$

$$I_2\,\omega^2\,\theta + \frac{2\ E\ I}{L^2}\left(2\ \theta\ L^2 - 3\ z\ L\right) + K\ \dot{\theta} = 0$$

and

$$M\ \ddot{z} + \frac{m\ L}{210}\left(78\ddot{z} - 11\ L\ \ddot{\theta}\right) - \frac{m\ \omega^2\ L}{210}\left(78\ z - 11\ L\ \theta\right)$$

$$M\ z\ \omega^2 + \frac{2\ E\ I}{L^3}\left(6\ z - 3\ \theta\ L\right) = 0$$

Which when collected in a convenient form, become

$$\left[\left(I_2 + \frac{2}{210}m\ L^3\right)D^2 + K\ D + \left(I_2\,\omega^2 - \frac{2}{210}\,m\,\omega^2\,L^3 + \frac{4\ E\ I}{L}\right)\right]\theta$$

$$-\left[\frac{11}{210}\,m\ L^2\ D^2 + \left(\frac{6}{L^2}\ E\ I - \frac{11}{210}\,m\,\omega^2\,L^2\right)\right]z = 0$$

and

$$-\left[\frac{11}{210}\,m\ L^2\ D^2 + \left(\frac{6\ E\ I}{L^2} - \frac{11}{210}\,m\,\omega^2\,L^2\right)\right]\theta +$$

$$\left[\left(M + \frac{78}{210}m\ L\right)D^2 + \left(\frac{12\ EI}{L^3} - M\,\omega^2 - \frac{78}{210}m\,\omega^2\,L\right)\right]z = 0$$

So that the complete motion is given by the solution of the differential equation:

$$\left.\begin{array}{c} \left[\left(I_2 + \frac{2}{210}m\ L^3\right)D^2 + K\ D + \left(I_2\,\omega^2 - \frac{2}{210}m\,\omega^2\,L^3 + \frac{4\ EI}{L}\right)\right] \\ \left[\left(M + \frac{78}{210}\,m\ L\right)D^2 + \left(\frac{12\,E\,I}{L^3} - M\,\omega^2 - \frac{78}{210}\,m\,\omega^2\,L\right)\right] \\ -\left[\frac{11}{210}\,m\ L^2\ D^2 + \left(\frac{6\ E\ I}{L^2} - \frac{11}{210}\,m\,\omega^2\,L^2\right)\right]^2 \end{array}\right\}\theta = 0$$

Owing to the large number of algebraic terms—several of them having neglible values—no advantage is to be gained by attempting to solve the differential equation of the fourth order in its present form. By the substitution of the numerical values of the symbols the equation may be written in the form

$$(D^4 + A_1\,D^3 + A_2\,D^2 + A^3\,D + A_4)\,\theta = 0$$

where A_1, A_2, A_3, A_4 are numerical constants. For all practical purposes the values of A_1 and A_3 are each equal to zero, so that the equation is reduced to $(D^4 + A_2\ D^2 + A_4)\ \theta = 0$.

The air-screw and shaft commence to whirl when the frequency of one of the transverse vibrations just becomes zero, so that at the whirling speed the solution of the equation

$$(D^4 + A_2\,D^2 + A_4)\,\theta = 0$$

becomes

$$\theta = B_1 + B_2\,t + B_3 \sin \beta\,t + B_4 \cos \beta\,b$$

where B_1, B_2, B_3 and B_4 are arbitrary constants depending on the initial conditions. For a rotational speed less than the whirling speed the motion consists of two vibrations, while at a rotational speed greater than the whirling speed the motion is compounded of a vibration, a divergence and a subsider, so that if the divergence is allowed to persist the shaft fractures.

APPLICATION OF THE PRECEDING THEORY TO SEVERAL PRACTICAL PROBLEMS

With the object of simplifying the differential equation of the motion of the vibrating air-screw and shaft a systematic series of calculations has been made to ascertain how the frequency of the vibrations depends upon the damping, the mass and the length of the shaft, the mass and the moment of inertia of the air-screw.

The following data, which are needed in the calculations, have been taken from a modern two-bladed air-screw, which, rotating at about 1300 r.p.m., would give a machine weighing 1 ton a forward speed through the air of 75 miles per hour, the corresponding thrust being 300 lb., approximately.

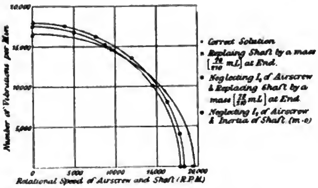


FIG. 3. TRANSVERSE VIBRATIONS IN A PLANE PARALLEL TO THE AXIS OF ROTATION AND AT RIGHT-ANGLES TO THE BLADE-AXIS L-05 FT. I_2 0-02 SLUG-(FT.)^2 HIGHER FREQUENCY NOT *PLOTTED*

Diameter of the air-screw = 9.5 ft.
Mass of the air-screw and metal fittings at the boss, M = 1.0 slug.
Outside diameter of the air-screw shaft = 2 in.
Inside diameter of the air-screw shaft = 0.9 in.
Whence moment of inertia of a section of the air-screw shaft about a diameter = 0.362×10^{-4} ft.^{4}.
Length of the air-screw shaft, L = 0.5 ft.
Mass of 1 ft. length of the air-screw shaft, m = 0.26 slugs.
Modulus of elasticity E = 4.17×10^9 lb. per square foot.
Moment of inertia of the air-screw about an axis passing through the center of the boss at right angles to both the air-screw axis and the blade axis = 3.5 slug-ft.^{2}.
Moment of inertia of the air-screw about the blade axis = 0.02 slug-ft.^{2}.
Hence

$$I_2 = 3.5 \sin^2 \alpha + 0.02 \cos^2 \alpha$$

Where α = angle between the blade axis and an axis passing through the center of the boss at right angles to the plane of vibration.

Only the two extreme values of I_2 were taken, namely, 3.5 when α = 90 deg. and 0.02 when α = 0 deg.

The rate at which energy is dissipated for this air-screw is 150 $\dot{\theta}^2$ ft.-lb. per second, when α = 90 deg. The damping when α = 0 deg. can be neglected at the commencement of the investigation.

The calculations are quite straightforward, although somewhat laborious, and it has been considered not desirable to overburden this paper with the complete calculations, so that only a summary of the results is given in the tables and shown graphically in the figures. It will be noted that the frequency of the transverse vibrations of the air-screw as mounted in practice is very high, much higher than the bursting speed of the air-screw, which is about 3500 r.p.m. and, accordingly, calculations were made for the air-screw mounted at the end of a shaft of length 2.5 ft. As stated at the commencement of the investigation it is assumed that the air-screw shaft is rigidly fixed at one end, but it is uncertain how far such a condition holds in practice, much depending on the rigidity of the engine frame and the method of mounting the air-screw shaft. Any want of rigidity at the end of the shaft will reduce for the same speed of rotation the frequency of the transverse vibrations. If the end conditions are different from those postulated in the present paper, but are definitely defined, the same method of calculating the frequency of the transverse vibrations may be employed, although the equation of the centre line of the shaft will be different.

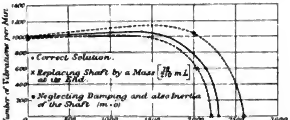


Fig. 4. TRANSVERSE VIBRATIONS IN A PLANE PARALLEL TO THE AXIS OF ROTATION AND TO THE BLADE-AXIS. L-2·5 FT. I_2-3·5 SLUG-(FT.)^2 HIGHER FREQUENCY NOT PLOTTED

The solution of the biquadratic $D^4 + A_1 D^3 + A_2 D^2 + A_3 D + A_4 = 0$ was greatly facilitated by the fact that the terms A_1 and A_3 are of small importance compared with A_2 and A_4, so that the biquadratic could be readily split into two quadratic equations by the method of trial and error. Of course, the solution of the biquadratic equation when the damping terms A_1 and A_3 are neglected is a matter of no difficulty.

From the data of the tables and figures it will be seen that the following conclusions may be drawn:

(*a*) The air damping of an air-screw is negligible, in so far as the frequency of the transverse vibrations is concerned.

(*b*) The whirling speed may be calculated with very good accuracy by assuming the effect of the shaft to be the equivalent of a mass $\frac{78}{210}\, m\, L$ at its end. In this case the whirling speed is overestimated, the inaccuracy increasing with the length of the shaft. The maximum error due to this assumption is only about 3.5 per cent of the true value of the whirling speed.

(*c*) As would be expected, neglecting the mass of the shaft makes the whirling speed too high, the discrepancy increasing with the length of the shaft, the maximum error due to the assumption being 13 per cent. of the true value of the whirling speed.

(*d*) It is seen from Figs. 3 and 5 that even when the moment of inertia I_2 of the air-screw is small—0.02 slug-ft.^{2} in this particular case—it should not be neglected in the calculation of the whirling speed.

(*e*) The whirling speed of an air-screw and shaft increases with the moment of inertia of the air-screw.

(*f*) When the moments of inertia of the air-screw—I_2 in this case—and of the shaft are zero, the whirling speed has the same frequency as the natural period of transverse vibration when not rotating.

A SIMPLE FORMULA FROM WHICH MAY BE CALCULATED THE WHIRLING SPEED OF ROTATION OF AN AIR-SCREW AND ITS SHAFT

It has been shown that the air damping of an air-screw may be neglected, and also that the effect of the inertia of the shaft is equivalent, for all practical purposes, to a mass $\frac{78}{210}\, m\, L$ placed at its end. The differential equation for the motion of the air-screw and shaft then becomes

$$\left\{\left[D^2 + \omega^2 + \frac{4\,E\,I}{L\,I_2}\right]\left[D^2 - \omega^2 + \frac{12\,E\,I}{L^3\left(M + \frac{78}{210} m\,L\right)}\right] - \frac{36\,E^2\,I^2}{I_2\,L^4\left(M + \frac{78}{210} m\,L\right)}\right\}\theta = 0$$

that is

$$\left\{D^4 + D^2\left(\frac{4\,E\,I}{L\,I_2} + \frac{12\,E\,I}{L^3\left(M + \frac{78}{210} m\,L\right)}\right) + \left(\omega^2 + \frac{4\,E\,I}{L\,I_2}\right) - \left(\frac{12\,E\,I}{L^3\left(M + \frac{78}{210} m\,L\right)} - \omega^2\right) - \frac{36\,E^2\,I^2}{I_2\,L^4\left(M + \frac{78}{210} m\,L\right)}\right\}\theta = 0$$

The whirling speed, that is, the rotational speed at which the frequency of one of the transverse vibrations becomes zero, is then got from the expression

$$\left[\omega^2 - \frac{12\,E\,I}{L^3\left(M + \frac{78}{210} m\,L\right)}\right]\left[\omega^2 + \frac{4\,E\,I}{L\,I_2}\right] + \frac{36\,E^2\,I^2}{I_2\,L^4\left(M + \frac{78}{210} m\,L\right)} = 0$$

which may be written

$$\omega^4 + \omega^2\left[\frac{4\,E\,I}{L\,I_2} - \frac{12\,E\,I}{L^3\left(M + \frac{78}{210} m\,L\right)}\right] = \frac{12\,E^2\,I^2}{I_2\,L^4\left(M + \frac{78}{210} m\,L\right)}$$

If the above equation be solved for ω^2, it will be found that there is one positive and one negative value. The whirling speed may be got by taking the square root of the positive value of ω^2. The result of the present investigation may be summarized as follows.

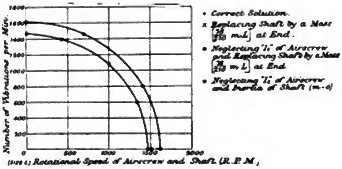


Fig. 5. TRANSVERSE VIBRATIONS IN A PLANE PARALLEL TO THE AXIS OF ROTATION AND TO THE BLADE-AXIS L-2·5 FT. I_2-0·02 SLUG-(FT.)^2 HIGHER FREQUENCY NOT PLOTTED

The critical speed, ω, of a rotating air-screw and shaft, the shaft being a cantilever fixed in direction at one end, may be calculated by taking the square root of the positive value of ω^2 got from the solution of the equation

$$\omega^4 + \omega^2\left(\frac{4\,E\,I}{L\,I_2} - \frac{12\,E\,I}{L^3\left(M + \frac{78}{210} m\,L\right)}\right) = \frac{12\,E^2\,I^2}{I_2\,L^4\left(M + \frac{78}{210} m\,L\right)}$$

where

ω = rotational speed in radians per second.
M = mass of the air-screw in slugs.
I_2 = moment of inertia of the air-screw about an axis passing through the center of the air-screw at right-angles to the plane of the transverse vibrations (slug-ft.^{2}).
L = length of the shaft in feet.
m = mass of one foot length of shaft in slugs.
E = Young's modulus in lb. per square foot.
I = moment of inertia of a cross-section of the shaft about a diameter in feet^4

If $I_2 = 0$ the whirling speed may be calculated from the equation

$$\omega^2 = \frac{3\,E\,I}{L^3\left(M + \frac{78}{210} m\,L\right)}$$

TABLE I.—*Summary of the Results of the Calculations made on a Modern Two-bladed Air-screw, Mounted as in practice on a Shaft of Length 0.5 ft.*

Case I.—Transverse vibrations in a plane parallel to the axis of rotation and to the blade axis. α = 90 deg. and I_1 = 3.5 slug-ft.². Bursting speed of air-screw about 3,500 r.p.m.

Assumptions made in Calculations.	Rotational Speed of the Shaft (r.p.m.).	Number of Vibrations per Minute.	
Complete solution, making no assumptions	0 5,000 10,000 15,000 20,000 25,000 30,000 34,000 35,000	2,770 5,900 10,100 14,800 19,000 21,700 17,800 9,000 0	35,800 35,600 34,200 31,600 29,700 28,800 31,400 34,900 35,800
Neglecting damping only	Results same as with no assumptions		
Neglecting damping and assuming effect of shaft to be equivalent of a mass $\left(\frac{78}{210}m\ L\right)$ at its end	0 28,700 35,100	2,785 19,400 0	35,800 30,300 35,600
Neglecting damping and also the inertia of the shaft ($m = 0$)	0 4,000 9,000 14,000 19,000 24,000 29,000 34,000 36,000	2,755 5,100 9,200 13,900 18,200 21,500 19,800 12,000 0	36,700 36,700 36,000 33,800 31,700 30,200 30,900 34,900 36,700

TABLE II.—*Summary of the Results of the Calculations made on a Modern Two-bladed Air-screw, Mounted as in Practice on a Shaft of Length 0.5 ft.*

Case II.—Transverse vibrations in a plane parallel to the axis of rotation and at right angles to the blade axis. α = 0 deg. and I_2 = 0.02 slug-ft.². No damping in this case. Bursting speed of air-screw about 3,500 r.p.m.

Assumptions made in the Calculations.	Rotational Speed of the Shaft (r.p.m.).	Number of Vibrations per Minute.	
Complete solution, making no assumptions	0 4,000 10,000 16,000 19,000 19,500	16,600 16,400 14,400 9,300 3,800 0	78,800 79,000 80,000 81,600 82,700 82,900
Assuming effect of the shaft to be equivalent to a mass $\left(\frac{78}{210}m\ L\right)$ at its end	0 19,300	16,400 0	Not calculated.
Neglecting I_2 which is very small in this case, and assuming effect of the shaft to be equivalent to a mass $\left(\frac{78}{210}m\ L\right)$ at its end	0 17,750	17,750 0	
Neglecting I_2 and also the mass of the shaft ($m = 0$)	0 18,150	18,150 0	

TABLE III.—*Summary of the Results of the Calculations made on a Modern Two-bladed Air-screw, Mounted at the End of a Long Shaft of Length 2.5 ft.*

Case I.—Transverse vibrations in a plane parallel to the axis of rotation and to the blade axis. α = 90 deg. and I_1 = 3.5 slug-ft.².

Assumptions made in Calculations.	Rotational Speed of the Shaft (r.p.m.).	Number of Vibrations per Minute.	
Complete solution, making no assumptions	0 500 1,000 1,400 1,800 2,200 2,280	1,000 1,200 1,060 1,070 950 490 0	3,640 3,630 3,620 3,620 3,650 3,750 3,770
Neglecting damping makes practically no difference to the frequency			
Neglecting damping and assuming effect of the shaft to be the equivalent of a mass $\left(\frac{78}{210}m\ L\right)$ at its end	0 1,910 2,220	990 760 0	3,720 3,770 3,780
Neglecting damping and also the inertia of the shaft ($m = 0$)	0 1,910 2,590	1,020 1,095 0	Not calculated.

TABLE IV.—*Summary of the Results of the Calculations made on a Modern Two-bladed Air-screw, Mounted at the End of a Long Shaft of Length 2.5 ft.*

Case II.—Transverse vibrations in a plane parallel to the axis of rotation and at right angles to the blade axis. α = 0 deg. and I_2 = 0.02 slug-ft.². No damping in this case.

Assumptions made in the Calculations	Rotational Speed of the Shaft (r.p.m.).	Number of Vibrations per Minute Frequency of the Higher Vibrations not Calculated.
No assumptions	0 1,565	1,500 0
Assuming effect of the shaft to be the equivalent of a mass $\left(\frac{78}{210}m\ L\right)$ at its end	0 1,510	1,480 0
Neglecting I_2, which is very small, and assuming effect of the shaft to be the equivalent of a mass $\left(\frac{78}{210}m\ L\right)$ at its end	0 1,460	1,460 0
Neglecting I_2 and mass of shaft ($m = 0$)	0 1,620	1,620 0

The Nieuport 1½ Plane Fighter

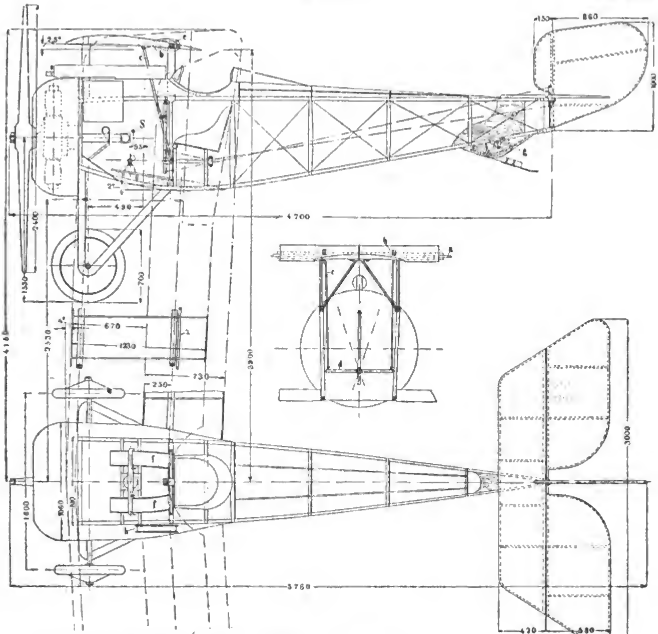
The Nieuport 1½ plane has, during the last year, become one of the most important fighter airplanes of the French Flying Corps, being in no mean way responsible for the aerial supremacy achieved by the Allies both on the Western and the Italian fronts. The following data and constructional details are abstracted from articles appearing in German aeronautical magazines.

Although various models exist, and often vary in minor details, the 1½ plane fighter is essentially a one-seater tractor biplane fitted with a rotary engine. Two-seater machines have also been built, but do not appear to be very widely employed. These are chiefly used for reconnaissance work and only occasionally for fighting. The forward gun fires through the propeller, while the after gun is mounted *en barbette*.

Official French Photograph

THE NIEUPORT BIPLANE

Model No. 11, produced in 1916 and since superseded by improved types, seems to have remained the prototype of the Nieuport 1½ plane fighter. Its constructional data are therefore of particular interest.



Scale Drawings of Model No. 11

Characteristics of the Nieuport Model No. 11

Span, upper	24 ft. 8 in.
Span, lower	24 ft. 3¼ in.
Chord, upper	3 ft. 11 in.
Chord, lower	2 ft. 5 in.
Overall length	18 ft. 10 in.
Height	8 ft. 1 in
Area, upper plane, with ailerons	97 sq. ft.
Area, lower plane	49.5 sq. ft.
Area, stabilizer	11 sq. ft.
Area, elevators	14.5 sq. ft.
Area, rudder	6 sq. ft.
Area, ailerons	14 sq. ft.
Stagger	2 ft. 3 in.
Dihedral, upper	179 deg
Dihedral, lower	174 deg.
Retreat	170 deg. 30'
Incidence, upper	1 deg. 30'
Incidence, lower	3 deg.
Power plant	80 hp. Le Rhône
Propeller, diameter	8 ft. 2½ in.
Climb	3,300 ft. in 1 min. 6,600 ft. in 7 min. 9,900 ft. in 11 min. 13,200 ft. in 16 min.

Apportionment of Weights

Upper plane, complete	79 lb.
Lower plane, complete	32 lb.
Stabilizer	7.7 lb.
Elevators	9.5 lb.
Rudder	6.6 lb.
Body, with engine complete	583 lb.
Wire stays	7.7 lb.
Wheels	22.1 lb.
Struts, interplane	11 lb.
Gross weight (empty)	760 lb.
Pilot	176 lb.
Gasoline (20½ gal.)	121 lb.
Oil (5 gal.)	44 lb.
Machine gun and ammunition	110 lb.
Useful load	451 lb.
Total weight (loaded)	1210 lb.
Lift loading	8.3 lb./sq. ft.
Power loading	12.1 lb./hp.

Among the more notable constructional features of the Nieuport is the use of a single spar in the lower wing, the consequent adoption of V-type struts and the possibility of varying the incidence on assembling; the novel method of mounting the ailerons on a tubular shaft carried all across the wing, and their operation by means of pull-and-push rods instead of control cables; and the rather startling use of aluminum alloy in the chassis construction. The cross member of the chassis connecting the V's is of channel section aluminum, while the chassis struts consist of drawn aluminum tubes. The wheel axle is, however, a steel tube, and the strut sockets are made of steel sheeting.

Model No. 17, which appears to be one of the latest models of the Nieuport fighter, is but slightly larger than the Model No. 11 and is chiefly remarkable for the circular section of the body in the neighborhood of the cockpit, and the spinner fitted to the propeller to reduce head resistance. Model No. 17 has a 110 hp. Le Rhône or a 130 hp. Clerget engine. It is worth noting that, unlike on the prototype, the lower plane is mounted at a lesser incidence than the upper plane and that the décalage between the planes is also much reduced. The incidence of the upper plane is 2 deg. 30', and that of the lower plane 2 deg.

The armament of the Nieuport fighter consists of one or two Lewis guns; if two are carried, one is generally mounted on the upper plane, while the other is mounted on the body in front of the pilot. Both emplacements are of the stationary type, and a synchronizing device is provided for firing the lower gun through the propeller, which the upper gun is prevented from doing by an appropriate guide.

Completion of the Liberty Engine

The successful completion of the U. S. A. or Liberty aircraft engine was announced in an official statement issued by the Secretary of War on August 12. The statement reads:

"The United States aviation engine has passed its final tests. They were successful and gratifying. The new engine, designated by the Signal Service as the 'Liberty engine,' is now the main reliance of the United States in the rapid production in large numbers of high-powered battle planes for service in the war. In power, speed, serviceability and minimum weight the new engine invites comparison with the best that the European war has produced.

"I regard the invention and rapid development of this engine as one of the really big accomplishments of the United States since its entry into the war. The engine was brought about through the cooperation of more than a score of engineers, who pooled their skill and trade secrets in the war emergency, working with the encouragement of the Aircraft Production Board, the War Department and the Bureau of Standards.

"The story of the production of this engine is a remarkable one. Probably the war has produced no greater single achievement.

"One of the first problems which confronted the War Department and the Aircraft Production Board after the declaration of hostilities was to produce a dependable engine. Two courses were open. One was to encourage manufacturers to develop their own types, the other to bring the best of all types together and develop a standard.

"The necessity for speed and quantity of production resulted in a choice of the latter course, and a standard engine became our engineering objective.

"Two of the best engineers in the country, who had never before seen each other, were brought together at Washington, and the problem of producing an all-American engine at the earliest possible moment was presented to them. Their first conference, on June 3, lasted from afternoon until half-past two o'clock in the morning.

"These two engineers were figuratively locked in a room in a Washington hotel and charged with the development of an airplane engine for use by American aviators over the battlefields of Europe. For five days neither man left the suite of rooms engaged for them. Consulting engineers and draftsmen from various sections of the country were brought to Washington to assist them. The work in the drafting room proceeded continuously, day and night. Each of the two engineers in immediate charge of engine development alternately worked a twenty-four-hour shift.

"An inspiring feature of this work was the aid rendered by consulting engineers and motor manufacturers, who gave up their trade secrets under the emergency of war needs. Realizing that the new design would be a Government design and no firm or individual would reap selfish benefit because of its making, the motor manufacturers patriotically revealed their trade secrets and made available trade processes of great commercial value. These industries have also contributed the services of approximately 200 of their best draftsmen.

"The two engineers locked together in a hotel room in this city promised the Government if given an opportunity they would design a satisfactory aero-engine before a working model could be brought from Europe.

"A remarkable American engine was actually produced three weeks before any model could have been brought from Europe. It was promised that this engine would be developed before the Fourth of July. Twenty-eight days after the drawings were started the new engine was set up. This was on July 3.

"In order to have the engine in Washington and in actual running order at the nation's capital on Independence Day the perfected engine was sent from a Western city in a special express car. The journey was made in twenty-one hours, and four young men guarded the engine en route to Washington and personally attended to its transfer from one railroad to another.

"With the need for speed as an incentive, tools for building the first engine were made even before the drawings were finished—on the assumption that they would be correct.

"Parts of the first engine were turned out at twelve different factories, located all the way from Connecticut to California. When the parts were assembled the adjustment was perfect and the performance of the engine was wonderfully gratifying. This in itself demonstrated the capabilities of American factories when put to the test and when thoroughly organized for emergency work of this sort.

"One of the chief rules outlined at the beginning of the designing work was that no engineer should be permitted to introduce construction which had not been tried out. There was no time for theorizing. The new engine is successful because it embodies the best thought of engineering experience to date. Not only did this country furnish ideas through celebrated consulting engineers, but the representatives in the United States of England, France and Italy cooperated in the development of this motor.

"Thirty days after the assembling of the first engine preliminary tests justified the Government in formally accepting the engine as the best aircraft engine produced in any country. The final tests confirmed our faith in the new engine in every degree.

"Both the flying and altitude tests of the new engine have been gratifying. One test was conducted at Pike's Peak, where the United States aviation engine performed satisfactorily at this high altitude. One of the engines in an airplane broke the American altitude record in a recent flying test.

"While it is not deemed expedient to discuss in detail the performances and mechanics of the new engine, it may be said that standardization is a chief factor in the development of the Government's engine. Cylinders, pistons and every other part of the engine have been standardized. They may be produced rapidly and economically by a great many factories operating under Government contracts. They may be as rapidly assembled, either by these plants or at a central assembly plant.

"The new engine amounts practically to an international model. It embodies the best there is in American engineering and the best features of Europan models, so far as it has been possible to adapt the latter to American manufacturing methods.

"The two engineers most directly connected with the production of the United States aviation engine had before them not only the blueprints and models of the most successful engines the war has produced but also every available American suggestion. Men skilled in the invention of motors, both automobile and airplane, advised these engineers who were charged with the duty of providing rapidly and unerringly an engine which would embody every essential of war time use. Non-essential complexities were consistently discarded by these engineers. The result was a composite design of maximum power, minimum weight, great speed capability and adaptability to quick production.

"The standardization of parts materially simplifies the problem of repair and maintenance. Spare parts will be promptly available at all times. Even the cylinders are designed separately. It is possible to build the new engine in four models, ranging from four to twelve cylinders, and under the standardization plan now worked out an eight-cylinder or a twelve-cylinder model can be made, using the same standard cylinders, pistons, valves, cam shafts, and so on.

"With the completion of final tests of the engine—tests which satisfied and gratified both expert engineers and army officers—progress already has been made toward organizing industry for the manufacture of the new machines and deliveries will begin within a comparatively short time."

NOTE:—At the request of the War Department no further information concerning the design, performance or manufacture of this engine will be printed at this time.—EDITOR.

The Sylphon Motor Thermostat

Proper control of the temperature of the cooling medium of an internal combustion engine adds much to the efficiency, economy, and satisfactory operation. There is one temperature of the medium at which the motor will give best results, and the ideal condition is to maintain this temperature constant. The Sylphon automobile thermostat accomplishes this in a simple manner.

In the case of a water-cooled engine, a by-pass is installed between the engine jacket intake and outlet, as shown by Figs. 2 and 3. By this means, water may pass out of the jacket through the by-pass and back into the jacket without circulating through the radiator. Whether the water circulates through the radiator or through the by-pass is determined by the Sylphon thermostatic valve shown in Fig. 1.

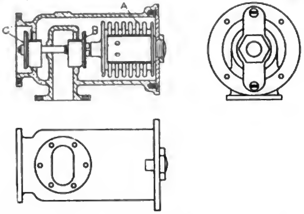


Fig. 1

The radiator valve, *C*, and the by-pass valve, *B*, are mounted on the same spindle—therefore, as either valve closes, the other opens. This double valve is moved by the Sylphon, *A*, which consists of an hermetically sealed, seamless, corrugated, metal vessel, containing a volatile liquid. Changes in temperature of the circulating water bring about changes in the vapor pressure of the volatile liquid, causing the Sylphon to expand or contract and producing motion of the valve.

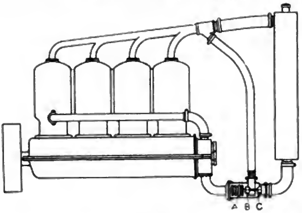


Fig. 2

By proper choice of the liquid it is evident that the thermostat may be set to open the valve allowing water to circulate through the radiator at a definite temperature. Any tendency to exceed this temperature is offset by the thermostat, which closes the by-pass and directs sufficient water through the radiator to reduce the temperature of the water in the jacket.

The radiator is designed to keep the cooling water at the efficient temperature during hard service in hot weather. Now if the motor operates most economically when the air temperature is 85 deg. F., the cooling medium around the cylinders is not at the proper temperature when the air is below this temperature, other things being constant.

Often the radiator is covered to secure satisfactory operation of the air temperature is around 0 deg. F. The Sylphon thermostat eliminates this difficulty. Also when starting, efficient operating temperature of motor is quickly reached, carburetor adjustment for weather conditions is unnecessary and lubrication is improved. With the motor stopped, the cooling medium loses heat more slowly. Metals having large coefficients of expansion may be used in engine construction and when two fuels are used, correct preheating of the operating fuel may be accomplished by passing the cooling medium through heating coils in the fuel passage.

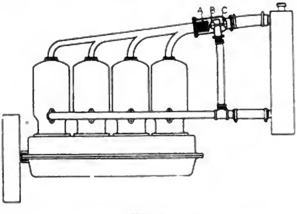


Fig. 3

The Sylphon thermostat may be used with any cooling medium and may be applied to any motor with perhaps a slight change in the design of the housing. A series of careful tests show a marked improvement in the economy of automobile engines using this device.

The Fulton Co. of Knoxville, Tenn., manufacturer of the Sylphon, is now working on an airplane thermostatic regulator.

Bain News Service *British Official Photograph*

BRITISH KITE-BALLOON IN TOW

Wire and Cable Standards Recommended by S. A. E.

The following extracts from the report of the Advisory Committee for Airplane Material, Specifications and Inspection were recommended for standardization at the Washington meeting of the S. A. E.

Aircraft Round Wire

This specification covers solid high strength steel wire, round section, used in the construction of aircraft when flexibility is of minor importance. A tension test is to be made on each piece or coil of wire. When an individual coil of wire is to be divided into smaller coils to meet special requirements it is sufficient to make one test on the original coil and to cut and seal the smaller coils in the presence of the inspector. Samples for tension test shall be no less than 15 in. long and free from bends and kinks.

TABLE OF PHYSICAL PROPERTIES FOR AIRCRAFT ROUND WIRE

Brown & Sharpe Gage	Diameter, In.	Minimum Torsion for 6 In.	Weight in Lb. per 100 Ft.	Number of Bends Through 90 deg	Breaking Strength, Minimum Lb.
6	0.162	11	7.01	5	4,500
7	0.144	12	7.01	6	3,700
8	0.128	14	4.40	8	3,000
9	0.114	16	3.50	9	2,500
10	0.102	18	2.77	11	2,000
11	0.090	21	2.20	14	1,620
12	0.081	24	1.744	17	1,300
13	0.072	27	1.383	21	1,040
14	0.064	31	1.097	25	830
15	0.057	34	0.870	29	660
16	0.051	39	0.690	34	540
17	0.045	44	0.547	42	425
18	0.040	49	0.434	52	340
19	0.036	55	0.344	70	280
20	0.032	61	0.273	85	225
21	0.028	70	0.216	105	175

In making tensile tests on aircraft wire the distance between jaws of testing machine with sample in place and before test shall be 10 in. Wire for this purpose must break at no less than the amount specified in the attached table which herewith becomes a part of this specification.

A torsion test is to be made on a sample cut from each piece or coil of wire as above. Samples for torsion tests shall be straight and no less than 10 in. long. The sample shall be gripped by two vises 6 in. apart; one vise shall be turned uniformly at a speed not exceeding 60 r.p.m. (on the larger sizes of wire this speed shall be reduced sufficiently to avoid undue heating of the wire). One vise shall have free axial movement in either direction. All wire shall be required to stand the minimum number of complete turns shown in the attached table.

A bend test is to be made on a sample cut from each piece of wire as above. Sample for bend test shall be straight and no less than 10 in. long. One end of the sample shall be clamped between jaws having their upper edges rounded to 3/16-in. radius. The free end of the wire shall be held loosely between two guides and bend 90 deg. over one jaw; this is to be counted as one bend. On raising to a vertical position the count will be two bends. Wire shall then be bent to the other side, and so forth, alternating to fracture. The minimum number of bends required is stated in the following table.

A wrapping test is to be made on at least 10 per cent of the total number of coils offered for inspection at one time. The wire shall be tightly wrapped eight consecutive turns around its own diameter with a pitch of substantially the diameter of the wire and then unwrapped maintaining the free end at approximately 90 deg. with the mandril.

It must stand this test without fracture. Because of the possibility of personal error in making this test, failure on one test is not considered conclusive and, if requested to do so, the inspector shall make at least one, but no more than two additional tests on the same piece of wire. If any of these tests are successful the material shall be passed as satisfactory in this respect.

All wire for this purpose shall be furnished in decimal sizes corresponding to the American Standard Wire Gage (Brown & Sharpe Gage). The wire shall be cylindrical and smooth and show no evidence of scrapes, splints, cold shuts and rough tinning, not conforming with best commercial practice. A permissible variation of 0.002 in. above gage on all sizes will be acceptable, but no wire will be accepted having a variation of more than 0.0005 in. below gage.

Single strand, multiple strand 6 by 7, 7 by 7, and 7 by 19.

A tensile test shall be made upon each individual reel of cable for shipment containing 10,000 ft. or more. On shipments of reels of cable containing less than 10,000 ft., each test shall be made for each 5000 ft. of a size. The tension testing machine shall be of a type satisfactory to the representative of the U. S. Government and shall be standardized with U. S. Standard Weights when considered necessary. Samples of cable for testing for tensile strength shall be no less than 24 in. long. In making tensile tests the distance between jaws of testing machine with sample in place and before test shall be no less than 10 in. Samples for tensile test may be clamped in the jaws of the testing machine in the usual manner to facilitate speed of testing, but in case of failure or dispute on individual tests and at the request of the manufacturer, check tests shall be made by socketing the samples with pure zinc. Cables

AIRCRAFT GALVANIZED SINGLE STRAND CABLE (Non-flexible)

Diameter of Cable, in.	Number of Wires	Breaking Strength of Cable, lb.	Approximate Weight lb. per 100 ft.
5/16	19	12,500	20.65
1/4	19	8,000	13.50
7/32	19	6,100	10.00
3/16	19	4,600	7.70
5/32	19	3,200	5.50
1/8	19	2,100	3.50
7/64	19	1,600	2.60
3/32	19	1,100	1.75
5/64	19	780	1.21
1/16	19	500	0.78
1/32	7	185	0.30

AIRCRAFT GALVANIZED MULTIPLE CABLE *6x7 COTTON CENTER (Flexible)

Diameter of Cable, In.	Breaking Strength of Cable, lb.	Approximate Weight lb. per 100 ft.
5/16	7,900	13.00
1/4	5,000	9.50
7/32	4,000	7.45
3/16	2,750	5.30
5/32	2,200	4.20
1/8	1,150	2.20
7/64	830	1.50
3/32	780	1.30
5/64	480	0.83
1/16	400	0.73

* Six strands of seven wires each.

REELS FOR AIRCRAFT STRAND AND CABLE*

Diam. of Strand or Cable	1000 FEET Diam. Head	1000 FEET Trav. or Dist. betw'n Heads	1000 FEET Diam. Bbl.	1000 FEET Diameter Arbor Hole	2000 FEET Diam. Head	2000 FEET Trav. or Dist. betw'n Heads	2000 FEET Diam. Bbl.	2000 FEET Diameter Arbor Hole
1/32	12	4	8	1¼	12	4	8	1¼
1/16	12	4	8	1¼	12	4	8	1¼
5/64	12	4	8	1¼	16	4	10	1¼
3/32	12	4	8	1¼	16	4	10	1¼
7/64	16	4	10	1¼	16	7	12	1¼
1/8	16	4	10	1¼	16	7	12	1¼
9/64	16	7	12	1¼	16	10	8	1¼
5/32	16	7	12	1¼	16	10	8	1¼
3/16	18	7	12	2¼	18	10	8	2¼
7/32	18	7	12	2¼	18	10	8	2¼
1/4	18	10	10	2¼	24	10	10	2¼
9/32	18	10	10	2¼	24	10	10	2¼
5/16	18	10	8	2¼	32	16	16	2¼
3/8	18	10	8	2¼	32	16	16	2¼

Diam. of Strand or Cable	5000 FEET Diam. Head	5000 FEET Trav. or Dist. betw'n Heads	5000 FEET Diam. Bbl.	5000 FEET Diameter Arbor Hole	10,000 FEET Diam. Head	10,000 FEET Trav. or Dist. betw'n Heads	10,000 FEET Diam. Bbl.	10,000 FEET Diameter Arbor Hole
1/32	12	4	8	1¼	16	4	10	1¼
1/16	16	4	10	1¼	16	4	12	1¼
5/64	16	7	12	1¼	16	10	8	1¼
3/32	16	7	12	1¼	16	10	8	1¼
7/64	16	10	8	1¼	18	10	8	1¼
1/8	16	10	8	1¼	24	10	10	1¼
9/64	24	10	10	1¼	24	16	10	2¼
5/32	24	10	10	1¼	24	16	10	2¼
3/16	24	10	10	2¼	24	16	10	2¼
7/32	24	10	10	2¼	32	20	16	3¼
1/4	32	18	16	2¼	36	22	18	3¼
9/32	32	18	16	2¼	36	22	18	3¼
5/16	32	20	16	3¼	50	16	26	3¼
3/8	32	20	16	3¼	50	16	26	3¼

In making racks for the above reels allow 4 inches more width than the traverse specified above. *All dimensions in inches.

for use in the construction of aircraft must break at no less than the amount specified in the attached table.

At least one bending test is to be made on a sample cut from each 50,000 ft. of cable of a given size. Each sample must be bent once around its own diameter and straightened again at least 20 times in succession in the same direction of bending without any of the wires breaking.

A torsion test is to be made on one wire from each sample of cable taken for tensile test. The wire is to be gripped by two vises 4 in. apart; one vise shall be turned uniformly at as high a rate of speed as possible without perceptibly heating the wire. One vise shall have free axial movement in either direction. The number, N, of whole turns through which the wire must stand twisting is given by the formula:

$$N = \frac{1.1}{d}$$

where d equals the diameter of the wire in inches. Failure of one piece of wire to show full number of turns specified in the above torsion test shall not be considered cause for rejection, but in each case two additional tests shall be made on two more wires from the same sample of cable and if both samples meet the requirements of the specifications the strand shall be accepted in this respect.

No variation is permissible below nominal diameter. Cable having a diameter of 1/32 to 5/32 in. inclusive shall have a permissible variation of 10 per cent. above size and cable having a diameter of 3/6 to $^3/_8$ in. inclusive shall have a permissible variation of 7 per cent above size.

AIRCRAFT GALVANIZED MULTIPLE CABLE *7x7 WIRE CENTER (Flexibl-)

Diameter of Cable, in.	Breaking Strength of Cable, lb.	Approximate Weight lb. per 100 ft.
5/16	9,200	16 70
1/4	5.800	10 50
7/32	4,600	8.30
3/16	3,200	5.80
5/32	2,600	4 67
1/8	1,350	2.45
7/64	970	1.75
3/32	920	1 45
5/64	550	0 93
1/16	480	0.81

* Seven strands of seven wires each.

AIRCRAFT TINNED MULTIPLE STRAND CABLE *7x19 WIRE CENTER (Extra Flexible)

Diameter of Cable, in.	Breaking Strength of Cable, lb.	Approximate Weight lb. per 100 ft.
3/8	14,400	26 45
11/32	12,500	22.53
5/16	9,800	17.71
9/32	8,000	14 56
1/4	7,000	12 00
7/32	5,600	9.50
3/16	4,200	6 47
5/32	2,800	4 44
1/8	2,000	2 88

* Seven strands of nineteen wires each.

Protective Coatings for Metals

The Aeronautic Division of the Standards Committee of the S. A. E. is now engaged in a study of the various kinds of anti-rust treatment of metals. This subject is exceedingly important at present, on account of the need for protecting many of the bolts, nuts and fittings used on aircraft from the action of the elements. It is planned to secure as many samples as possible of treatments making use of chemical or heat methods or a combination of the two, for protecting metals.

The Boyce Motometer

The Boyce Distance Type Motometer consists essentially of three main parts: the temperature responsive element or bulb, the flexible copper tubing which connects the bulb to the third part, the recording instrument.

The advantages of this instrument over the familiar Boyce motometer, so commonly seen on automobile radiators, are two-fold. In the first place, the temperature responsive element is located in the circulating water, and the temperature indicated on the registering dial is the actual temperature of the water, and not the temperature of the air above the water in the radiator, as is the case with the older type. Secondly, the indicating dial and mechanism can be placed on the dash of the automobile or on the instrument board of the airplane. This makes it far more convenient to read, and at the same time places the indicating mechanism in a position where there is less vibration from the engine.

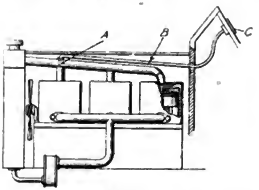


Fig. 1

The temperature responsive element is nothing more than a hollow bulb filled with an expansible fluid. This bulb is located in the cooling system, preferably in such a place as to be influenced by the cooling water after it has attained its highest temperature, and where it will be subject to the action of any steam which may form in the jackets.

The bulb is connected with the flexible hollow tube, which is also filled with the expansible fluid. The other end of the tube is carried to the instrument board, where it connects with the registering instrument. This part of the instrument comprises a Bourbon tube, with the exterior of which the bore of the flexible tube communicates, the free end of the Bourbon tube being connected by a suitable mechanism to the indicating number. Any increase in temperature of cooling water will cause the fluid in the bulb to expand, the pressure in the Bourbon tube will increase, and, in accordance with a well-known principle, it will tend to straighten out and bring the recording hand into play by a system of levers. Conversely, a cooling of the water will cause the fluid in the bulb to contract, thus relieving pressure in the Bourbon tube and permitting recording hand to return to its initial position. Any suitable temperature scale may be employed.

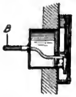


Fig. 2

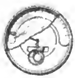


Fig. 3

In Fig. 1, the responsive bulb is shown located at A, with the flexible tube B leading to the Bourbon tube at C. Figs. 2 and 3 illustrate diagramatically the construction of the Bourbon tube and of the recorder.

New Aluminum Production Method

A method has recently been patented in this country for obtaining aluminum from aluminum carbide. The latter is mixed with 10 to 20 per cent, by weight, of oxide, chloride and sulphide of aluminum, and the charge is then reduced in a vertical electric furnace at 2100 to 2200 deg. C. under a pressure of 10 to 15 lb. per sq. in. above atmospheric. When alloys are required, oxide, chloride, or sulphide of the respective metal is added in such proportion as to obtain a neutectic alloy. In the case of copper, for instance, the proportions would be copper 5.8 per cent and aluminum 94.2 per cent.

Digest of the Foreign Aeronautical Press

Aeronautics (London), August 9, 1917

Aircraft Losses in July.—Our Air Service overseas had three famous days last month. The first was July 11, when our aerial activity seems to have borne no special relation to operations in the field. At any rate, our men destroyed fourteen German machines and drove down sixteen out of control, while another was shot down by gunfire from the ground. Again, as the inevitable prelude to battle nowadays, we got really busy before the third battle of Ypres. On July 28 we destroyed fifteen enemy machines and drove down sixteen out of control, and on the following day we crashed sixteen and caused another fourteen to spin down earthward. On these three days alone, therefore, we definitely accounted for 46 Germans, while the fate of 48 others is uncertain. Our loss for those three days was 25 machines missing, not all of which necessarily crashed or were brought down as the result of air fighting. The following are the complete figures of the month's losses on the Western front:

Destroyed by British in aerial combat, including four machines which fell in our lines and nine destroyed on returning from raids on England	131
Destroyed by British gunfire, including two in our lines	5
Destroyed by British trawler on East Coast	2
Destroyed by French in aerial combat	47
Destroyed by French gunfire	8
Destroyed by Belgians in aerial combat	6
Destroyed by Belgian artillery	2
Total German loss	201
Number driven down by British out of control, including one by anti-aircraft fire	127
Number driven down in enemy lines by French	54
Total	181
Total number of English machines missing	92
Total number of Allied machines claimed as destroyed by the enemy, including one French machine in Westphalia and two anti-aircraft victims	130

One word of caution. The term "driven down out of control" should not be taken too literally, for a spinning nose-dive is today one of the accepted battle maneuvres.

The American Air Service in France.—Evidence of the close cooperation between the American Air Service and that of the Allies, and of the earnestness of the effort about to be put forward by the United States—if it were needed—is afforded by the character and record of the men our latest Ally is sending over to prepare the way for her. On Aug. 2 Lieut.-Colonel Mitchell, director of the American Air Service in France, was the guest of honor at a reception given by the Aero Club of France in Paris, whereat he was presented with a silver medal. Speeches were made by the president of the club, M. d'Estournelles de Constant, the well-known Senator, and M. Daniel Vincent, Under-Secretary for Military Aeronautics. Lieut.-Colonel Mitchell possesses a fine record as a soldier, having been through the campaigns in Mexico, Cuba and the Philippines as a combatant, and the Russo-Japanese War as military attaché. He has passed the French tests as a fighting pilot and holds the Croix de Guerre awarded him for a noteworthy bombing raid over German territory.

Aeronautics (London), August 15, 1917

A Visit to a Bombing Group.—Hugues le Roux, aeronautical editor of the Paris Daily *Le Matin*, gives an interesting description of his visit to a French bombing "group," the latter unit being the equivalent of the American and English "wing" and consisting of three or more squadrons.

"By day bombs are released from a great altitude. This makes for inaccuracy of aim, but at the same time renders them more effective against the population of big cities, especially when the streets are crowded.

"Destruction raids are better carried out at night. They meet with practically no interference from the enemy, and can be effected from a height of 2,500 to 5,000 feet.

"Sometimes, pilots have told me, we come down as low as 1,500 feet over a railway station; this gives one the sensation of depositing the bomb with your hand, as it were. During the month of June our group dropped 3,700 lb. of bombs in daylight raids and 135 tons in night raids. When our men dropped 3,500 lb. of bombs on the railway and aerodrome of Chateled-sur-Retourne, the enemy admitted that close to $5,000,000 worth of munitions were destroyed in the fire which broke out.

"In short distance raids there is not much to choose between the French and the German, but in long distance raids the French are unquestionably superior. They carry them out almost daily. Treves (68 miles), Karlsruhe (109 miles), Ludwigshafen (124 miles), Coblentz (155 miles), Rottweil (93 miles), Essen (235 miles), Munich (217 miles), Stuttgart, Luxemburg, Dillingen, Sarrebruck are all within reach of their bombing squadrons.

"When questioned about the future, a pilot made the following reply, which is particularly interesting in view of America's air program: 'The aerial establishment attached to army corps (that is, reconnaissance and artillery airplanes) is now adequate. Fighting machines, both in quality and quantity, must be superior to those of the enemy. There lies their limit. But there are no limits to the expansion of the bombing branch of the service. There is no material obstacle in the way of our possessing 500,000 bombers one day. Landing grounds abound in Champagne in the sectors of Noyon and Soissons, and this, our dream, we present to our new Allies over the water.'"

Aeronautics (London), August 22, 1917

The British Air Service Work in July.—During the month of July, 1917, the British Air Services (Royal Flying Corps and Royal Naval Air Service) on the Western front brought down 122 German airplanes and drove down 120 machines out of control. In all, 1,940 enemy batteries were located; it enabled the artillery to destroy 345 battery emplacements; 973 were hit and damaged, and 935 explosions were caused in the enemy's lines.

Death of James Valentine.—The death of Maj. James Valentine, R.F.C., is reported from Kieff, Russia, as the result of wounds received in action with an enemy airplane. Major Valentine was attached to the Russian Air Service in an organizing capacity, with the rank of lieutenant-colonel.

James Valentine was one of the few English sportsmen, who had taken up aviation as a pastime prior to the outbreak of the war. He obtained his pilot certificate in 1910, at Brooklands, on the Macfie biplane, which was one of the first English-built machines, and soon developed into a brilliant aviator. Valentine achieved particular prominence in the European Circuit, in July, 1911, and in the *Daily Mail* Circuit of Great Britain, where he secured third place, being the only English pilot to complete the course within the prescribed time. In 1912 he acted as pilot of the British and Colonial Aeroplane Co. (Bristol) in the British Military Trials at Salisbury Plains. Subsequently, he participated in several great races, notably the Aerial Derby, until the war, when he joined the Royal Flying Corps.

With the rank of captain he was sent to Paris, where his services won for him the Cross of the Legion of Honor. He was subsequently transferred to the Russian front, which he reached partly by the air route, one assumes, by flying from Salonica to Bucharest. While on the Russian front the Distinguished Service Order was bestowed upon him.

Major Valentine was one of the most popular figures in the world of aviation and all old-timers will deeply mourn his untimely departure.

The Growth of the Acetylene Welding Industry, by a correspondent.

General Remarks Relating to Autogenous Welding, etc., by G. Wüthrich, M.I.E.E.

Scientific Welding.

High-Pressure System of Oxy-Acetylene Welding.

Oxy-Acetylene Welding Equipment.

A series of articles dealing exhaustively with the principle of autogenous welding, and the equipment and operation thereof.

Espana Automovil (Madrid), July 30, 1917

An Aviation School at Barcelona.—An aviation school has recently been organized, through the efforts of the Aero Club of Cataluña, near Barcelona. D. Salvador Hedilla, a Spanish aviator, is chief pilot of the school. The other instructors are Domingo Rosillo, the Cuban aviator, Francisco Coterillo and Valentin Diaz, the two latter being Spaniards.

The flying equipment comprises two Blériot Penguins, fitted with 45 hp. Labor-Aviation engines, used for ground work; one 45 hp. Hedilla-Anzani monoplane; two Vendôme-Le Rhône 50 hp. monoplanes and two Hedilla-Le Rhône 80 hp. monocoques. A Gnome 50 hp. Morane-Saulnier monoplane, which belongs to one of the pilots, is also kept at the school.

Flight (London), August 16, 1917

Standardization of Parts.—An international committee to standardize the metal parts of aircraft is now sitting in New York, and the result of its labors is expected to be that these parts will be reduced to a few standard shapes, thus facilitating aircraft production on an enormous scale for the use of the Allies. On the face of it, this is an excellent thing, but we trust it will not be overdone. The international committee will do well to keep it in mind that aircraft design is progressing almost from day to day, and that the best machine of today is hopelessly inferior to that of tomorrow.

Undoubtedly, there are many metal parts and fittings of aircraft, which can be very usefully standardized, but, on the other hand, it is possible to overdo the manufacture of standardized parts that there would be serious danger of machines being turned out after they had become obsolete merely because contracts for particular designs had been placed on a basis of stocks of parts. We have suffered from the same sort of thing here, as we have had to point out in the columns of *Flight* more than once, though not so much from over-standardization as from want of prevision.

The main trouble seems to be that when parts have been ordered in large quantities and contracts placed for the resultant machines, no one cares to take the responsibility of ruthlessly scrapping an obsolete design. That is the case in businesses which have adopted the manufacture of the standardized article. We see it in the case of the cheap American car, which, although it may be a good enough production for the work it has to do, nevertheless lags hopelessly behind the practice of the day. In that case, its want of up-to-dateness, if we may call it that, does not matter because it does not claim to be the best, nor does its work demand that it should necessarily be the best.

The fact remains, however, that the first object of its manufacturers is a huge output before everything. That can only be attained through absolute standardization of parts, which carries with it the disability that standardization carries to an extreme is of necessity the sworn enemy of progress.

Standardization is very much like business "systems." It is an excellent thing so long as it is kept in subjection and made to serve the interests of its masters. Put it in the position of master instead of servant and it becomes a drag on the wheels. We are by no means against the work of the international committee.

On the contrary, if it is kept within reasonable limits we can well see that it will assist materially in the acceleration of the production of aircraft for the purposes of the war, but we think it is as well to utter a warning lest it should strive for over-standardization and thus actually retard instead of helping along the acceleration of production, so far as the best and most up-to-date types are concerned.

Flight (London), August 23, 1917

A New Aluminum Alloy.—In the endeavor to find an alloy combining lightness with strength, many metals have been tried in combination with aluminum. The merit of originality can certainly be claimed for the latest project, for it is claimed that by combining about 8 to 10 per cent of calcium, an alloy is obtained which is 5 to 20 per cent lighter than aluminum and possesses machining properties superior to aluminum or any of its other alloys.

It is suggested as being suitable for light castings such as airplane fittings, possessing the advantages of low specific gravity, the best machining properties it is possible to obtain and freedom from brittleness, while it should be capable of taking the finest impressions from the mold.

It would appear that the calcium acts as a flux and a detergent or purifier, converting the aluminum into a true homogeneous metal with the qualities that go therewith, and preventing the formation of oxide while the original metal or the subsequent castings are being made.

Naturally this alloy cannot be made by simple fusion of the mixed metals because the calcium itself burns, even when heated at a low temperature. To make the alloy, calcium in small pieces is pushed under the surface of the melted aluminum and held there until melted.

Flying (London), August 15, 1917

Aero Engine Induction, by Vincent Clarke, A.M.I.C.E., M.I.M.E., being a summary of the problems confronting the operation of carburetors employed on aero-engines. The following quotation is of particularly pertinent importance at the moment when the fighting level of pursuit airplanes is being daily carried higher and higher:

"From the pilot's point of view there is still room for a great deal of improvement in the supply of gasoline to the carburetor itself when the aircraft is rising rapidly or stalling, and the problem of carburetion is increasingly difficult in the case of military aircraft, which have to be varied in all manner of directions owing to the maneuvering necessary while fighting.

"This has taken place at altitudes of over 20,000 feet, so it is quite apparent that the problem of altitude has been to a considerable extent thrust upon the attention of the designer and the manufacturer of these engines. Probably, at present, the influence of altitude is one of the most important considerations regarding carburetion, and in dealing with this the advantages of forced induction become apparent.

"It is possible that great alterations in design may be made, and interconnected with the problem of carburetion is the question of compression at these high altitudes: therefore both factors have to be taken into account. Engines having a compression ratio as high as six to one are running satisfactorily at sea-level today, but this has been rendered possible only by evolving such a combination of features as valves of suitable design, diameters, and openings, and by going into the matter of cylinder head design very scientifically.

"Incidentally, it may be mentioned that together with this notable increase in the economy and compression ratios there has been a considerable increase in the mean effective pressure, and measured from the brake horsepower a mean effective pressure of as much as 134 lb. per square inch has been obtained from the latest designs of engines."

Aeronautical Journal (London), April-June, 1917

Methods of Measuring Aircraft Performances, by Capt. H. T. Tizard, R.F.C.

The Screw Propeller in Air, by M. A. S. Riach, A.F., A.E.S.

The High Tension Magneto, with Special Reference to the Ignition of Airplane Engines, by A. P. Young, A.M.I.E.E., A.I.E.E.

Another series of the excellent lectures on aeronautical subjects, for which the Aeronautical Society of Great Britain has more recently received just fame. These lectures are of such a wholesome nature that no abstract would render them full justice.

The Aeroplane (London), August 8, 1917

The Production of Aeroplanes and Their Components. Eighth installment. By Stepney Blakeney.

Aero-Motors in Kind and Construction, by Geoffrey de Holden-Stone.

The Case of Autogenous Welding, by Artifex.

The Aeroplane (London), August 15, 1917

Aero-Motors in Kind and Construction. By Geoffrey de Holden-Stone.—A comparative study of two well-known French rotary engines, the Le Rhone and the Clerget.

The Le Rhone discussed is the 9-cylinder, 110 h.p. model, with a bore of 105 mm. and a stroke of 140 mm. The Clerget 130 h.p. model, also a 9-cylinder type, has a bore of 120 mm. and a stroke of 150 mm. Both engines are also produced as a 7-cylinder model, with the identical cylinders as the above; the smaller Le Rhone develops 85 h.p., and the Clerget 90 h.p.

The weight of the 7-cylinder Clerget is 234 lb. and that of the 9-cylinder model 395 lb.

A clear description is given of the valve-gear systems used. On the Le Rhône, the cam-plate is mounted concentrically to the shaft axis, while the Clerget is fitted with a star-cam, which is mounted excentrically on the crankshaft.

The Production of Aeroplanes and their Components. By Stepney Blakeney. (Ninth instalment.)

News of the Fortnight

Legal Status for Aircraft Board

The Sheppard bill giving a legal status to the Aircraft Board, having charge of the $640,000,000 aircraft program, was passed in the Senate on September 12. The board, if the bill becomes a law, will consist of the Chief Signal Officer of the Army, the Chief Constructor of the Navy, and seven civilian members who will receive salaries of $7,500 each. No contracts can be made by the board without the approval of the War and Navy Departments.

French Air Services United

An official decree published in Paris on August 18 announces the fusion of the French Army and Navy Air Services under the single direction of the Sub-Secretary of State for Aeronautics. The latter, who is directly responsible to the French Parliament, has hitherto been only in charge of the Army Air Service, the Navy Air Service having been under orders of the Minister of Marine. The position of Sub-Secretary of State for Aeronautics is at present filled by M. J. Dumesnil.

The decree also emphasizes that the French Air Services will act in close cooperation with the air services of the Allies.

H. B. Oakleaf Called to Capital

Howard B. Oakleaf, head of the department of lumber research in the U. S. district forest office at Portland, Ore., has gone to Washington, D. C., under orders to report as adviser in the purchase and inspection of wood materials for aircraft.

Mr. Oakleaf is well known to western lumber dealers. He took forestry work at Yale in 1906 and was graduated from the Baltimore forest school in Asheville, N. C., in 1908. He entered the United States forest service the same year at Washington, D. C.

$30,000 for Torpedoplane

Godfrey L. Cabot, president of the Aero Club of New England and a vice-president of the Aero Club of America, has put $30,000 at the disposal of Rear Admiral Bradley A. Fiske, U. S. N., retired, the inventor of the torpedoplane, for the development of a craft capable of carrying and launching a full-sized torpedo, the weight of which is 2000 pounds.

In announcing his gift Mr. Cabot said he was convinced the torpedoplane offered the only apparent means of destroying the German fleet, which, in Kiel and Wilhelmshaven, is protected from attack by other war vessels, rows of mines and shore batteries. Mr. Cabot intimated also that if $30,000 were not enough for the purpose he would enlarge his contribution.

Corporation Takes Over Factory

The Grant Hammond Manufacturing Corp. has taken over and is operating the drop forging and machine plant formerly operated by M. Seward & Sons Co. and the Maxim Munitions Corp. at New Haven, Conn.

New Company to Make Airplane Engines

Henry M. Leland and Wilfred C. Leland, who recently resigned as president and general manager of the Cadillac Motor Car Co., Detroit, Mich., have completed the organization of a $1,500,000 company.

The concern has been incorporated as the Lincoln Motor Co. and has a factory composed of buildings formerly occupied by the Rands Mfg. Co. One hundred men are now at work and it is announced that 2000 will be employed soon. An output of 20 airplane engines per day is planned.

New Wright-Martin Officials

S. H. Humphrey has been appointed general manager of the Wright-Martin Aircraft Corp., New Brunswick, N. J. Mr. Humphrey formerly was manufacturing manager of Chalmers, and later of Briscoe & Hupp.

John R. Cantley, who has been for some time engineer for Peter A. Frasse & Co., New York City, has joined the engineering forces of the Wright-Martin Aircraft Corp. He is making his headquarters in Washington, D. C.

More Funds for Naval Aviation

The Urgency Deficiency bill, which was committed to the Committee of the Whole House and ordered to be printed on September 6, provides among other things for the Navy, a fund of $35,000,000 for aviation.

This amount is "to be expended under the direction of the Secretary of the Navy for procuring, producing, constructing, operating, preserving, storing and handling aircraft; maintenance of aircraft stations; and for experimental work in the development of aviation for naval purposes; Provided, That the sum to be paid out of this appropriation under the direction of the Secretary of the Navy for drafting, clerical, inspection and messenger service for aircraft stations shall not exceed $175,000."

The bill provides, in addition to numerous other appropriations, a portion of $3,000,000 for "war balloons and airships and accessories, including their maintenance and repair," at the Panama Canal.

Col. Roosevelt Flies with "Liberty" Engine

Col. Theodore Roosevelt recently had a flight in an airplane fitted with the new "Liberty" engine at Mineola.

The Colonel rode in the observation seat of an L. W. F. biplane, driven by H. W. Blakely. Most of the flight was at a height of between 5000 and 6000 feet.

C. L. Taylor Joins Aircraft Company

The announcement is made that Charles L. Taylor, president of the Carnegie Fund Hero Commission, with associates, has become affiliated with the Loughead Aircraft Manufacturing Co. of Santa Barbara, Cal.

A Santa Barbara site for a large plant, the only one in the West, has been secured, and it is said that within ninety days the concern will be able to make deliveries of various types of planes for war duty.

Swedish-German Air Route Planned

A committee has been formed in Stockholm with a view of establishing a regular airplane route between Trelleborg, in southern Sweden, and Sassnitz, Germany. It is asserted that a Swedish banker has offered 4,000,000 kroner ($1,000,000) for financing the enterprise.

The existing ferryboat service between Trelleborg and Sassnitz, besides being slow, is often interfered with by floating mines and allied submarines. An airplane service would therefore furnish both a quicker and much safer means of transportation than is at present available.

Aviators Leave Huntington, L. I.

Flying has stopped at the Huntington seaplane camp on Huntington Harbor, L. I., and the men, as well as the equipment, are being redistributed at other bases.

To Train Aviators in New York State

The bill to make the practice in acquiring land in New York State for Federal aviation fields, the same as the law covering the taking of land for fortifications, was signed September 11 by Governor Whitman. The act will take effect immediately.

At the request of Secretary of War Baker and under an emergency message from Governor Whitman of New York State, a bill was received by the New York Legislature Sept. 5 to make the practice in acquiring land in the State for Government Aviation Fields the same as the law governing the taking of land for fortifications. Immediate passage of the bill was asked so that there might be as little delay as possible in the acquisition by the Government of property to be used for aviation purposes.

Secretary Baker said that it was "probable that the United States Government in the near future will find it necessary to purchase some tracts of land in New York State for various purposes, particularly for the establishment of flying fields for the aviation service."

Cuban Aero Squadron for France

Colonel Coronado, a member of the Cuban Senate, is organizing an airplane squadrilla which will be offered, completely equipped, to the French Republic. This *Escadrille Cubaine,* as the unit is officially called, will be Cuba's first contribution of fighting men to the Allied cause.

Colonel Coronado's plans called for a body of twenty-five trained aviators to comprise the escadrille, but already thirty-three youths, who are representatives of the best families of Cuba, have volunteered to take the prescribed aviation course and individually to bear the expense of their airplanes and equipment. Many of the volunteers for the escadrille are graduates of French universities, and all speak French and are aviation enthusiasts. Senator Coronado has just returned from New York where he conferred with officials.

The colonel has asked the Navy Department in Washington for an arrangement by which the Cuban aviators may undergo their preliminary training at the navy aviation school at Pensacola, Fla.

Resnati Makes New Air Record

Captain Resnati of the Italian Army, a member of the flying corps instructing American aviators at Norfolk, Va., remained in the air for six hours on September 13 in a Caproni triplane which carried ten passengers, establishing a new record for a continuous flight with passengers.

He left the earth at 12.30 in the afternoon and returned at 6.30 o'clock. He flew over all the Virginia peninsula almost out to the Virginia Capes and far back into the country.

New World's Distance Record

Capt. Giulio Laureami, of the Italian Army Air Service, established, on August 29, a new world's distance record for airplanes by flying from Turin to Naples and back without a stop, a distance of 1,472 kilometers (920 statute miles) in air-line.

Captain Laureami used a new airplane, built by the Società Italiana Aeroplani of Turin and fitted with a Fiat engine. He left Turin at 10.07 a. m., reached Naples at 12.30 p. m., and was back in Turin at 8.40 p. m.

The previous world's distance record was established by Lieut. Antoine Marchal, of the French Army Flying Corps. In June, 1916, Marchal flew from Nancy, France, to near Cholm, Russian Poland, in a Nieuport biplane. This distance covered was about 807 miles. During the flight Lieut. Marchal dropped proclamations on Berlin. He was made prisoner by the Austrians at Cholm and was interned at Salzerbach.

The next best distance record was held by Second Lieut. Michel Draguseanu of the Roumanian Army Flying Corps, who flew on July 21, 1917, from Salonica to Kuluskaia (Bessarabia), a distance of nearly 1000 kilometers (625 miles). During his flight, which carried him over Bulgaria and Roumania, Draguseanu dropped proclamations on Bucharest and Constanza, and had several combats with enemy airplanes, two of which he shot down.

The American long-distance, non-stop record is held by Miss Ruth Law, who flew 590 miles from Chicago to Hornell, N. Y., on Nov. 19, 1916. Her elapsed time was 5 hours and 45 minutes.

Accept U. S. Buying Commission Agreement

Secretary McAdoo announces that formal agreements have been signed by the Secretary of the Treasury, with the approval of the President, on behalf of the United States, and by the Ambassador of Italy and the Ministers of Belgium and Serbia providing that all purchases by these Governments in the United States shall be made through the recently created commission composed of Bernard M. Baruch, Robert S. Lovett and Robert S. Brookings.

Similar agreements previously were signed with representatives of Great Britain, France and Russia.

The members of the commission are also members of the recently created War Industries Board of the Council of National Defense, and will thereby be able to thoroughly coordinate the purchases of the United States Government with the purchases of the Allied Powers.

R. B. Maxwell with American Propeller

Mr. R. B. Maxwell, assistant curator of the section of wood technology, National Museum, has resigned to accept a position as chief inspector with the American Propeller & Manufacturing Co. of Baltimore, Md.

Permits Americans to Keep War Medals

Senator Lodge's bill to permit Americans to retain decorations received from Allied Governments for military service when they enter the American army was passed September 12 by the Senate and has gone to the House. The present law forbids such decorations on American soldiers.

Many Americans who have been decorated for valor want to join their country's forces, but hesitate to give up the marks of bravery they have won. Among these are members of the Lafayette Escadrille, the flying corps of Americans attached to the French army.

Army Flying School at Fort Worth

The Signal Corps has made arrangements to establish a flying school at Fort Worth, Tex., where English instructors will assist American officers in preparing American flyers for air service on the Western front.

American student flyers are already under training in the Royal Flying School at Toronto, Canada. During the winter conditions are less favorable for flights in Canada, so about November 1 the instructors, students, and some of the equipment will be transferred to the Fort Worth school, a name for which has not yet been adopted. It is expected that by that date a sufficient portion of the barracks, machine ships, class rooms, hangars, etc., will be completed to provide for the opening of the school.

Four squadrons—600 men—will probably be under training in the new school when completed. Some of these will be machinists necessary to keep planes and engines in proper condition. A large number of such men are required with every flying unit.

American and English instructors are considered by the Signal Corps an ideal combination. In teaching students to fly no country is acknowledged to have developed a better system than the United States, but in turning out men trained for actual fighting our instructors lack the actual experience of the English instructors.

The Fort Worth school will follow the practice pursued at other large schools of having several flying fields within flying distance of each other, but widely enough separated to give the student flyers plenty of room when in the air. It is roughly figured that a square mile is a good allowance for two squadrons whose flying equipment is 72 planes. Usually not more than 36 of those would be in the air at one time.

Bonus for Bay State Recruits

Lieut. Charles J. Glidden of the Aeronautical Division, Department of the Northeast, announces that Massachusetts will pay $10 a month in addition to the $100 salary to young men training as aviators and observation balloon pilots.

The training lasts six months. Then the flyers are commissioned first lieutenants at $2,000 a year.

Navy Airplane Factory Up with Rush

Work has been rushed to such good effect upon the new million-dollar airplane factory to be built at League Island, that parts of the concrete foundations and brick superstructure are already in place.

Day and night shifts of workmen are being used on the building.

Allied Aviators Here

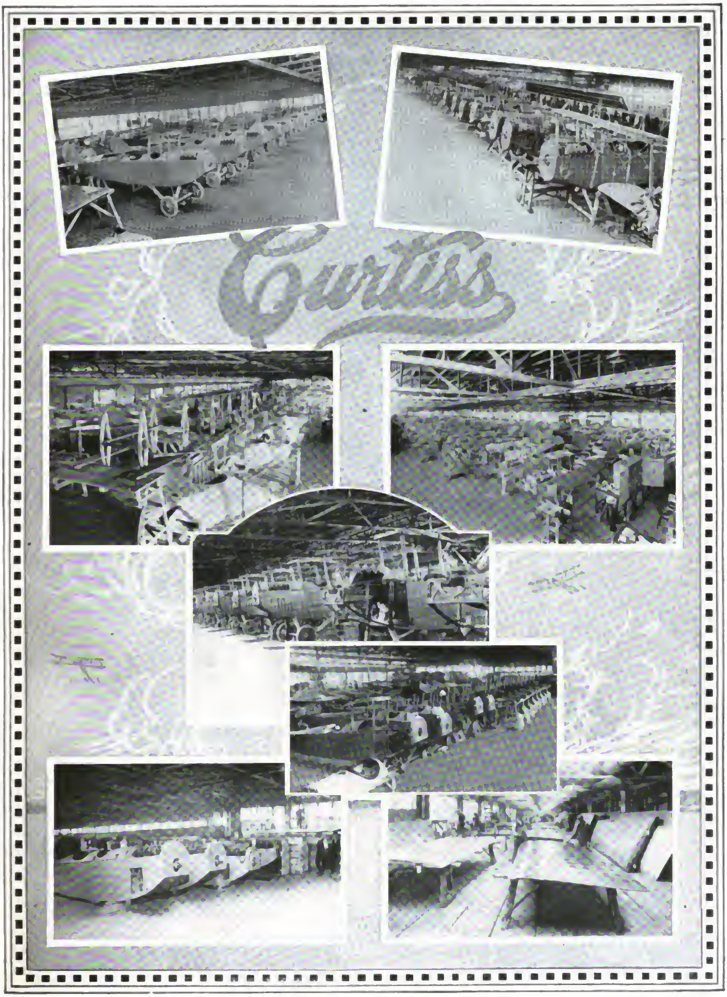
Eight Italian army officers, mostly from the aviation corps, arrived at an Atlantic port recently under command of Capt. Carlo Tappi. The object of their trip will be to purchase and inspect American airplanes and materials.

With the Italians were three more French aviation officers, who will serve as instructors to American airmen, and five officers of the United States Army who have been studying the needs of our forces in England and France.

Airplane Carries 25 Passengers

Captain Resnati, of the Royal Italian Flying Corps, established a new weight-carrying record for airplanes when, on September 14, he carried 24 passengers a distance of 50 miles, in the neighborhood of Norfolk, Va.

As soon as weather conditions permit, Captain Resnati's Caproni airplane will be flown from Old Point Comfort to New York, carrying at least twelve passengers. The maximum passenger-carrying capacity of the huge machine is twenty-four.



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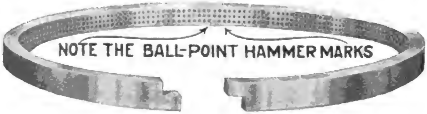
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American Hammered Piston Rings are recognized as the most mechanically perfect piston ring made to-day.

They are used exclusively as standard equipment by

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We have developed a new type of ring which is absolutely essential for an aeroplane motor. Send us blue prints of your piston and we will gladly forward full particulars.

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The Goodyear Kite-Balloon

The kite-balloon perfected by Goodyear combines the principles of the man-lifting kite and the captive balloon.

The first was unpractical because it required a strong wind.

The second was unsatisfactory because its use was limited to periods of calm.

Neither was stable, nor free enough from veering and yawing.

The Goodyear type of kite-balloon has fused the operating principles of both, selecting the best in each, so that it serves in storm and calm and furnishes a fixed, unwavering eye for artillery and fleet.

The carefully adjusted inclination of the elongated bag makes the plane of its nether surface a kite when the wind is on its front, and a resistant plane when the air currents are heavy on the back of the bag.

The refinements of keel construction, steadying side fins, and stabilizing tail-cups are Goodyear contributions to steadiness in air.

Every factor necessary to the fusion of the principles of kite and balloon has been developed or perfected —either in design or in material, or both.

Everything in Rubber for Airplanes
Balloons of Any Size and Every Type

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AERUL
A practical quality oil for aeroplane motors
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Quality Oils and Greases Since 1855

¶ Distributor and jobber connections desired for sales to mills, factories, machine shops, foundries, railways, and automobile accessory and hardware dealers. Write for full particulars regarding territory, prices, etc. ¶ See Sept. 29 and Oct. 6 issues of the "Saturday Evening Post" for description of the Swan & Finch line of Atlas grease and oil specialties—*Aerul, Gearese, Motul, Slo-Flo, Textul, Talcse, Asbestese, Corul, Cupcse, Marinul.*

CRANKSHAFT QUALITY

Stands out as the one requirement today of the builder of

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Experience only can produce a product to equal these demands.

Wyman-Gordon Company for many years, in their Research, as well as their Manufacturing Departments, have been developing along the lines that make them today able, without experiment, to supply crankshafts of

UNQUESTIONED RELIABILITY

Every stage in the production of a Wyman-Gordon crankshaft is subjected to rigid inspection and tests guaranteeing a high metallurgical quality.

Behind this perfect product is a perfect service.

Prompt attention to all orders and deliveries without delay.

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Airplane Parts!
Immediate Delivery!

Fortunately, the present crisis finds the Standard Parts Company ready to help you greatly in the rush demand for airplanes.

We are able to ship immediately necessary parts for the construction of airplanes the government must have in a hurry.

You can order from us at once such parts as:

Steel Tubing
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Tubing formed per B/P's and straight tubing in diameters ranging from ¼" to 2½", 14 gauge (.083") to 22 gauge (.028")

Special Rod Assemblies
Rims of all sizes to government specifications
Bearings
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For years we have made oval and "D" shaped tubing for the Curtiss Airplane Co.

Let us help you make your estimates.

Write us for information at once before you submit your bids for airplane construction.

If you have already made a contract, wire or write us immediately and take advantage of the instant service we can render you.

The factories of this company have been among the foremost in the field of motor-driven vehicles since the earliest days of the industry. Our engineering department and our laboratories are among the most complete in the world.

The Standard Parts Company, Cleveland, Ohio, U. S. A.
Famous for Stanweld Rims, Tubing, etc., Perfection Springs, Bock Bearings, Axles, Perfection Heaters, Forgings, Hubs, etc., etc.

Safeguarding the Airplane Motor

On the perfect performance of the motor depends the entire life of the airplane and its occupants.

¶ The use of the **BOYCE MOTO METER** gives to the pilot at all times an unfailing indication of the motor's condition. Its accuracy is absolute, its construction a masterpiece of scientific design.

¶ The Boyce Moto-Meter is standard equipment on 65 motor cars, trucks and airplanes.

¶ The great success of this motor heat indicator has been due to its extreme accuracy. Its action is unfailing.

¶ Such an instrument unless accurate, is worthless.

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To supply the increasing demand for our product the *Excelsior Propeller Company* has been forced to increase its facilities. We have reorganized our company under the new name of the

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and will occupy a modern three story factory at Piqua, Ohio, with 50,000 sq. ft. of floor space and all equipment necessary for the efficient manufacture of propellers in large quantities.
From now on our propellers will be produced from American Walnut, guaranteeing greatest *durability and best possible finish.*

With our new facilities we can give our customers prompt, efficient and satisfactory service.

HARTZELL WALNUT PROPELLER CO.
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ANNOUNCEMENT!

In view of the urgent requirements of the United States Government for

Resistal Aviator's Goggles

we are compelled to ask purchasers of RESISTAL AVIATOR'S GOGGLES to wait for shipments until we deliver to the Government.

Shortly after October 1, 1917, we will be in a position to ship orders for RESISTAL AVIATOR'S GOGGLES—just approved and standardized by the United States Signal Corps.

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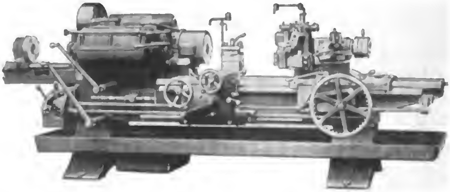

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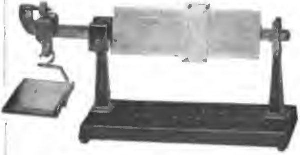

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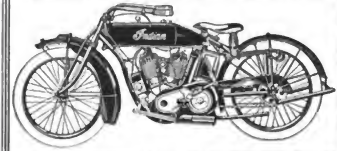

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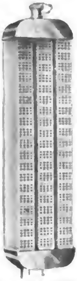

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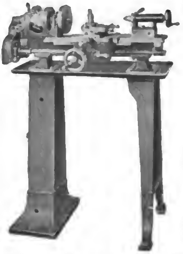

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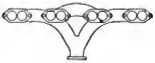

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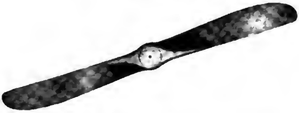

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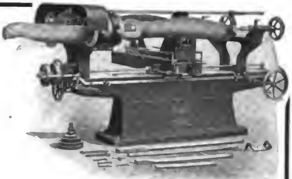

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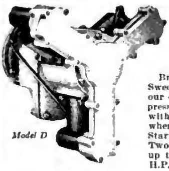

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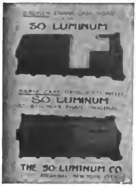

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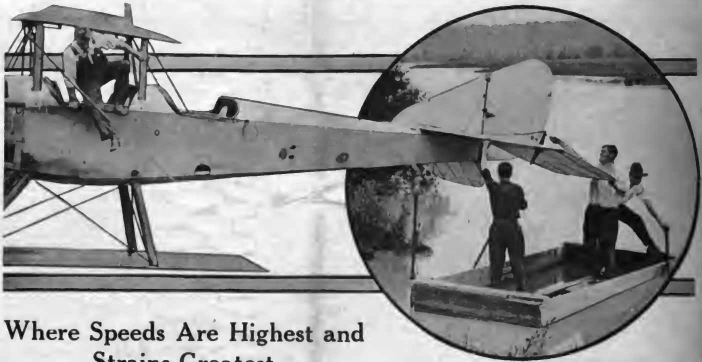

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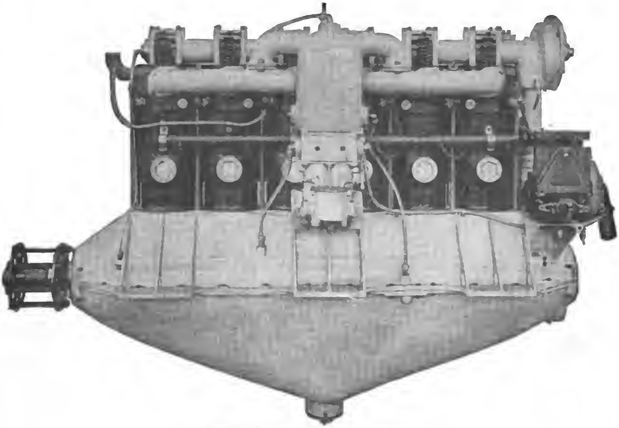

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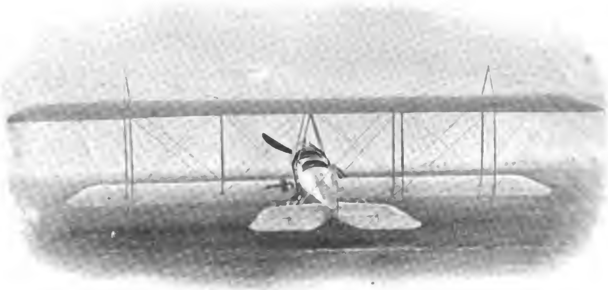

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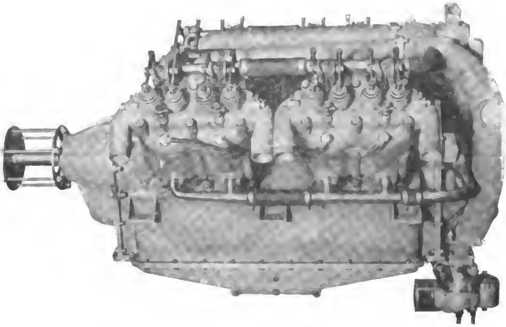

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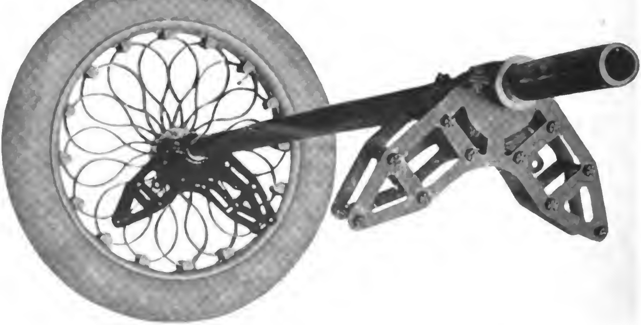

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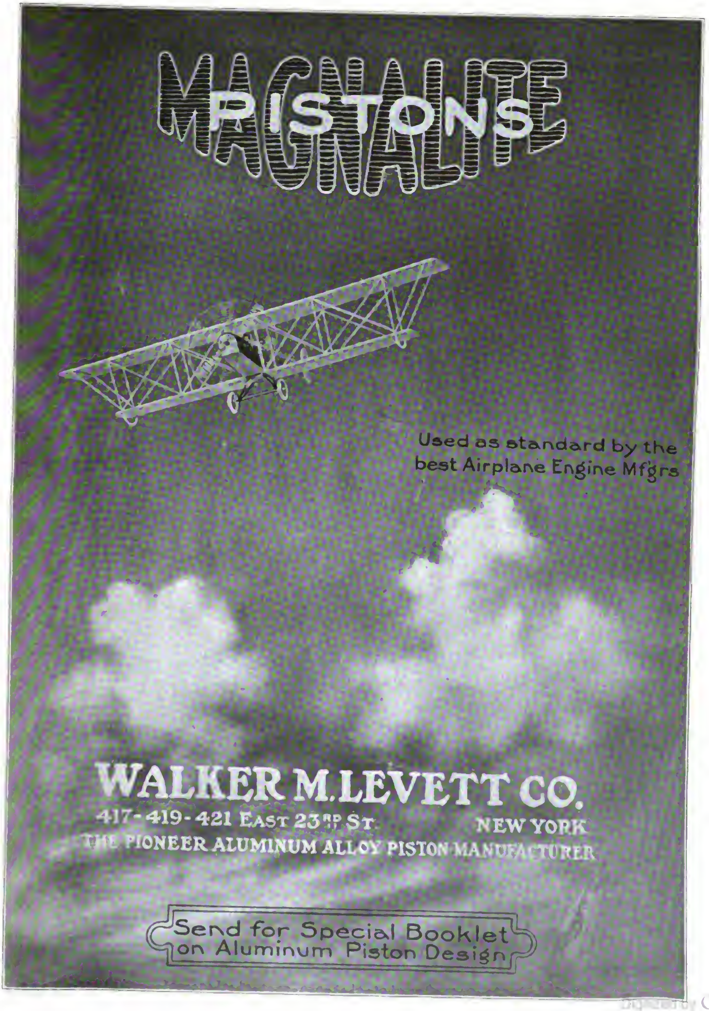

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AVIATION AND AERONAUTICAL ENGINEERING

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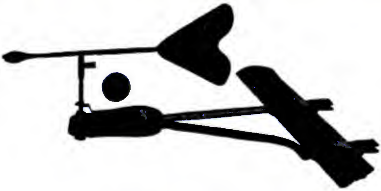

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AVIATION
AND
AERONAUTICAL ENGINEERING

Vol. III October 1, 1917 No. 5

Strut Charts

By H. M. Buckwald, M.E.

of the Engineering Department, Standard Aero Corp.

Calculations of struts form an important part of airplane design. There are the interwing struts, the interior wing stays for drift, the body longerons and the body struts. There are also the struts of the landing gear.

Usually the lengths of these members are known, and also the load to which they will be subjected, the latter being obtained from the stress diagrams. The problem then is to find the cross-sectional area that will enable the strut to fulfill the conditions.

Struts are regarded as columns, and either Rankine's or a modification of Euler's formulae is used. Rankine's formula for pin-connected struts is:

$$\frac{P}{A} = \frac{f}{1 + a\left(\frac{L}{k}\right)^2} \text{ where}$$

P = Crippling load of struts in pounds.

A = Area of section in sq. in.

f = Fibre stress. 5600 lbs./sq. in. for spruce. (R. A. F. Data.)
6250 lbs./sq. in. for ash.

L = Strut length in inches.

k = Least radius of gyration of section in inches.

a = A constant which depends on the value of L/k. See Fig. 1.

The results of Hunsaker's experiments on spruce struts are given in the following formulae:

For pin-connected struts

$$\frac{P}{A} = 6500 - 46.5\frac{L}{k} \text{ when } L/k \text{ is less than 70.}$$

$$\frac{P}{A} = \frac{8.72E}{\left(\frac{L}{k}\right)^2} \text{ when } L/k \text{ is greater than 70.}$$

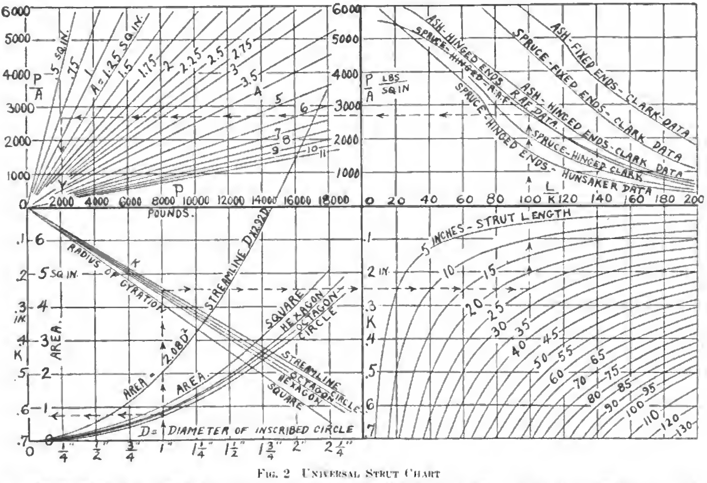

Fig. 2 Universal Strut Chart

For use in finding the crippling load of any size and length of spruce and ash struts. Example: Find the crippling load of a circular spruce strut one inch in diameter and 25 inches long; pin-connected at the ends. Use the R.A.F. data. The dotted line shows the method of procedure. Start at the lower left-hand corner at $D = 1''$. Run vertically until the area curve for circles is reached. Looking at the area scale to the left we note that the area of a one-inch circle is .785 sq. in. We proceed vertically along our D line until we reach the radius of gyration line for circles. Then project horizontally to the right until we reach our 25-inch line. Now run vertically upward to the spruce-hinged R.A.F. line. Then project horizontally to the left until the proper area line is reached. In our case it is .785 sq. in. Then drop vertically downward and we see that the crippling load of our strut is 2100 pounds.

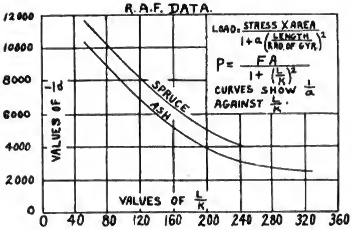

Fig. 1

E is the modulus of elasticity of spruce 1,825,000 lbs./sq. in. The other symbols are as before.

The common procedure in figuring a strut of known length to resist a certain load, is to assume an area, calculate its radius of gyration, and then to use one of the above formulae and see what crippling load our chosen section will have. This usually falls above or below our required load, and so several values of area must be tried. This involves much computation, and, in order to avoid this, the following charts have been constructed.

Fig. 2 represents a universal strut chart which, as the name implies, may be used to find the crippling loads of struts for any section, material, length, and also for various end connections such as round, fixed, or one end round and the other fixed, and for any experimental data.

The sections shown are stream-line, square, hexagonal, octagonal, and circular. In the upper right-hand corner of the

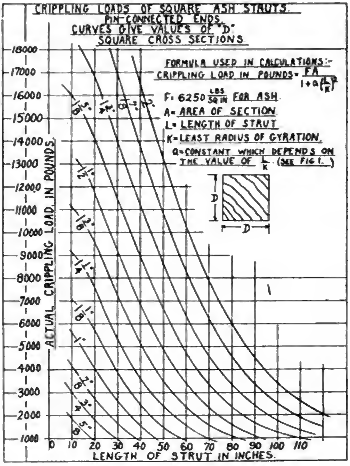

Fig. 3

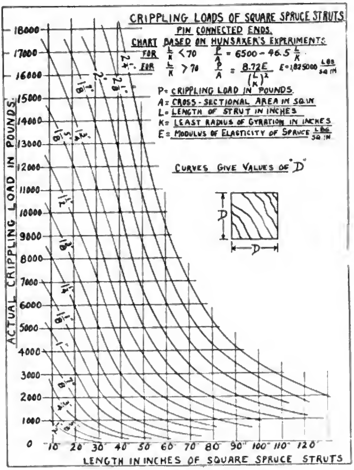

Fig. 4

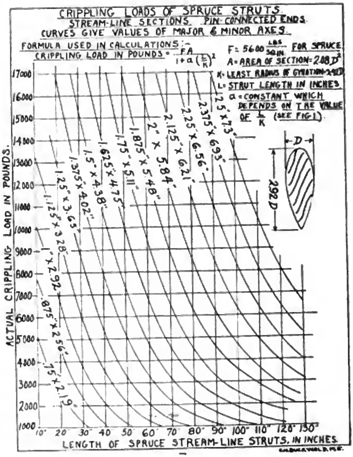

Fig. 5

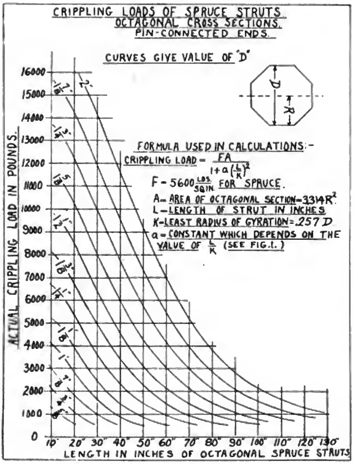

FIG. 6

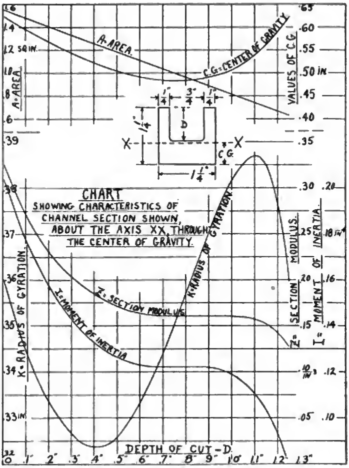

FIG. 8

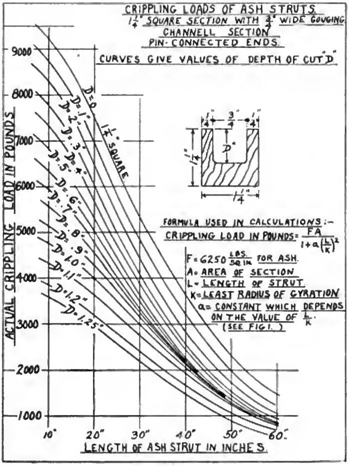

FIG. 7

chart there are plotted experimental results of R. A. F., Clark, and Hunsaker.[*]

From this universal chart special charts may be constructed which show at a glance the size of strut necessary for a given load and length.

These are represented in:

Fig. 3 for square ash sections: R. A. F. data.
Fig. 4 for square spruce sections: Hunsaker data.
Fig. 5 for stream-line spruce sections: R. A. F. data.
Fig. 6 for octagonal spruce sections: R. A. F. data.
Fig. 7 for channel ash sections: R. A. F. data.

All of these Figs. 3 to 7 inclusive, are for pin-connected ends.

The channel section shown in Figs. 7 and 8 is very interesting. As is well known, the longerons of the body are often channeled out for lightness. The section shown is 1¼ in. sq. ash. The least radius of gyration occurs about the axis XX, Fig. 8. The various characteristics of this section are shown in Fig. 8, and if we take these values of area and radius of gyration and use them in the universal chart, we may construct Fig. 7, which shows the depth of channeling for any length and load.

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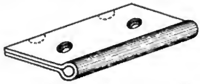
[*] R. A. F. Data, *Flight*, Oct. 18, 1913, p. 1149.
Clark's Data, *Aerial Age*, Aug. 7, 1916, p. 635.
Hunsaker's Data, *Aerial Age*, Aug. 16, 1916, and AVIATION AND AERONAUTICAL ENGINEERING, June 15, 1917, p. 442.

Controls and Control Surfaces

In the article on "Controls and Control Surfaces," by W. J. Waterhouse, printed in the September 1 issue of AVIATION AND AERONAUTICAL ENGINEERING, the "dotted half circles" referred to under the subject of "Hinges" were omitted. They appear in the illustration printed herewith.



The Shaping of Airplane Propellers*

By Frank W. Caldwell

After the propeller has been glued up it will usually be found that the glue has set in about twelve hours. The propeller may then be removed from the clamps.

When the propeller is glued up the boards will nearly always be distorted somewhat so that strains in the wood will be introduced from this source. Additional strains are introduced from the drying out of the moisture in the glue. For this reason it is considered good practice to let the propeller stand about a week before roughing it out.

Where the propeller has been glued up in step form, the rough shaping is usually done by means of a duplicating machine or by some form of router. A good many of these have been built and some of them are shown in the accompanying sketches.

Fig. 1 shows a rather crude form of rough shaping device which seems to work very well.

Fig. 2 shows a form of cutter that is said to have been used in England for rough shaping propellers. (*Aeronautics*, Nov. 22, 1916.) The English device appears to have been built up especially for propeller work.

There is a tool already on the market, however, made by the U. S. Electrical Tool Co., Cincinnati, O., which is adaptable for this work. This tool is preferable to a cutter on a flexible shaft as the greater inertia of the tool shown prevents it from jumping or making a wavy cut. An attempt has been made to use the same apparatus for sanding but this has been unsatisfactory, as the sand roll has a tendency to jump and produce rough work.

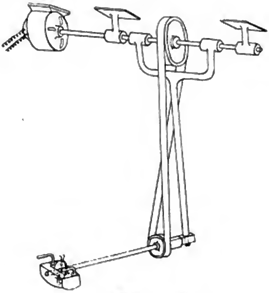


Fig. 1

Machine for Roughing Propellers With Motor and Belt Drive. This Machine, Like that Shown in Fig. 2, Is a Form of Router and is Manipulated Entirely by Hand. Its Success Depends Somewhat on the Skill of the Operator.

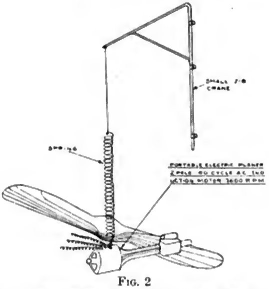

SMALL JIB CRANE
SPRING
PORTABLE ELECTRIC PLANER 2 POLE 60 CYCLE AC INDUCTION MOTOR 3600 RPM

Fig. 2

Cutter and Motor for Roughing Propellers Suspended from a Light Jib Crane by Means of a Spring. The Spring Suspension is Preferred to a Pulley and Counterweight, as It Is Found in Practice to Give Greater Freedom of Movement. In Case the Ceiling Is as High as 15 Ft. the Jib Crane May Be Omitted and the Spring Suspended Direct from the Ceiling.

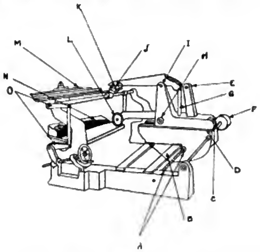


Fig. 3

Form of Propeller-Shaping Machine Manufactured by Wadkin & Co. of Leicester, England. The Sketch is Only Intended to Illustrate the Principle of Operation.

A, lead screw and nut for longitudinal feed; *B*, ways for longitudinal; *C*, lever to cam for cross feed; *D*, ways for cross feed; *E*, belt drive to cutter; *F*, source of power; *G*, equalizing link to maintain uniform distance between cutter and guide roller; *H*, pivot of guide roller support; *I*, pivot of cutter support; *J*, shroud for cutter; *K*, cutter; *L*, guide roller; *M*, propeller; *N*, form; *O*, equalizing linkage to keep axes of propeller and form parallel, which allows the blade to be kept nearly horizontal and permits free movement of the rollers.

Fig. 3 shows an automatic propeller shaping machine manufactured by Wadkin & Co. of Leicester, England. Little information is available as to what results this machine has given in practice. The cutting stroke is across the blade with

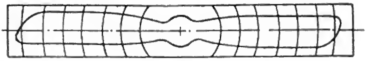


Fig. 4

Horizontal Projection of the Propeller Laid Out.

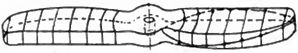


Fig. 5

Block Sawed Out to Shape of the Horizontal Projection and the Vertical Projection Is Laid Out for Working Down to Angles.

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* The present article is the second of a series dealing with the construction of airplane propellers which has been contributed by the author to Aviation and Aeronautical Engineering, the first article having appeared in the issue of May 1, 1917.

a longitudinal advance at the end of each stroke. The cutting stroke of machines built in this country has been along the blade with a cross feed at the end of the stroke.

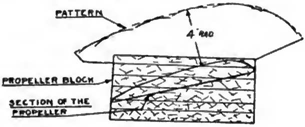


Fig. 6

The Pattern for Obtaining Guide Lines for Sawing Out the Back of the Propeller.

This sketch should be considered with Figs. 5 and 7. The flat piece of the propeller sawed out along the line shown in the right blade of Fig. 5. A pattern similar to that shown in Fig. 6 is then sawed out for each station and the patterns are tacked to the back of the block. This enables the saw man to obtain guide lines as shown in Fig. 7.

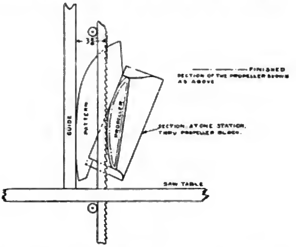

GUIDE
PATTERN
PROPELLER
FINISHED SECTION OF THE PROPELLER SHOWN AS ABOVE
SECTION AT ONE STATION THRU PROPELLER BLOCK.
SAW TABLE

Fig. 7

Figs. 4, 5, 6 and 7 show the method of laying out and rough-forming the propeller on a bandsaw. This method is used when the propeller has been glued together in the form of a block.

Fig. 8 shows a diagrammatic sketch of a machine which has been used in this country for duplicating. The machine is provided with a guide roller, which rolls on a form of the shape of a propeller, and of a cutter having the same shape and dimensions as the guide roller. Parallel motion of the guide and the cutter is obtained by means of two horizontal ways and two vertical ways. This machine will reproduce with a fair degree of precision, but is too slow and requires too much setting up for production work.

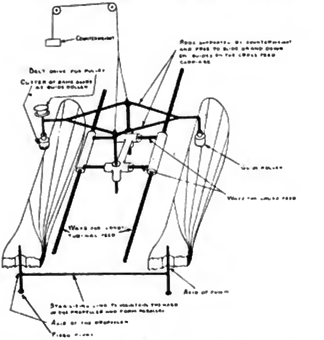


Fig. 8

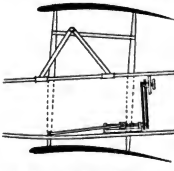
Recently a few propellers have been roughed out on a machine whose operation is about the same as that of an axe-handle lathe. This machine produces very nice work, apparently, and may develop into the most practical machine yet brought out.

The Paul Schmitt Airplane

By John Jay Ide

The Paul Schmitt airplane, one of the largest French tractor biplanes, is distinguished by a very ingenious means for varying the angle of incidence of the wings in flight. Before proceeding to describe the means employed to obtain this result, the disadvantages of the fixed angle of incidence may be briefly dwelt upon.

It is easily proved that in horizontal flight maximum efficiency can be obtained only at the speed at which the machine flies with its body horizontal. Any variation of speed, in the case of a conventional airplane, causes a change of the flying angle of the whole machine. Thus the line of flight is no longer parallel to the center line of the body. Consequently the air, instead of flowing smoothly along the body and causing skin friction only, strikes it at an angle—at higher speeds on top, at lower speeds on the bottom. In both cases loss of efficiency is the result.



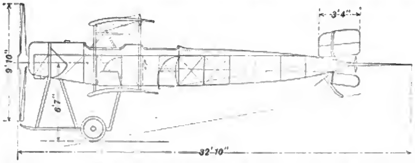
Method of Altering Angle of Incidence

Let us suppose, for example, that a machine flying with its body horizontal will maintain a horizontal flight path with its engine running at three-quarter maximum speed. Now, if we increase the speed of the engine to the limit, we shall have to decrease the angle of incidence in order to maintain a horizontal flight path. Otherwise the machine will start to gain altitude. As the angle of the wings relative to the body is fixed, we are forced to change the attitude of the whole machine, i.e., fly "tail high."

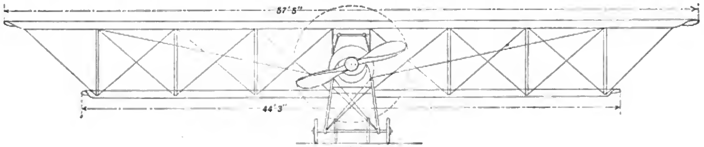
Likewise for low speeds, the engine is throttled down and the angle of incidence increased by flying with the tail low. This position is always dangerous, as a tail slide may result from sudden failure of the power plant. In the case of the Paul Schmitt airplane, however, the body can be maintained horizontal at all speeds by simply changing the angle of the wings to suit conditions. The method of accomplishing this is shown in the sketch.

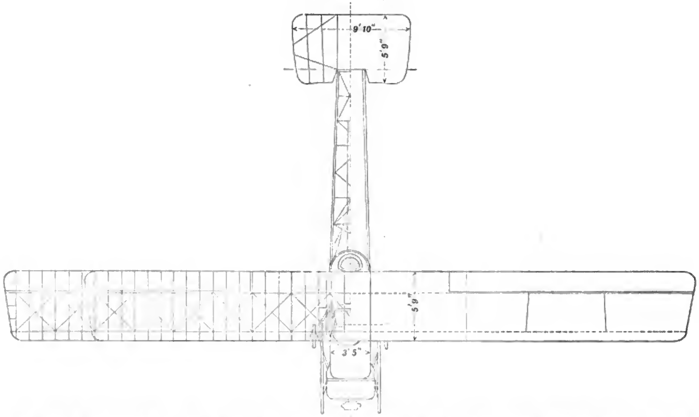
The two main planes form a unit entirely distinct from the body, which passes between the planes without touching either of them. They are connected to the body by means of a transverse tubular shaft, resting in ball bearings on a pair of inverted V stanchions and bolted at their lower ends to the upper longerons of the body. The ends of the transverse shaft are rigidly attached to two steel tubes placed fore and aft between the front and rear interplane struts. These four struts pass through the body by means of slots in the covering and are connected transversely at top and bottom by other tubes.

From the above description, it will be seen that the wings could rotate around the transverse axis until the interplane struts finally came in contact with members of the body. They are prevented from doing this by means of a large nut working on a threaded shaft borne on ball bearings and attached longitudinally to the floor of the body. This nut is connected by two pivots to a pair of interplane struts.



On a prolongation of the longitudinal shaft behind the rear bearing are mounted two concentric sprockets from which chains pass to two handwheels in front of the pilot. Rotation of the large wheel causes the shaft to revolve slowly while the small one is geared so that a more rapid movement is obtained.





As the threaded shaft rotates to left or right, the nut is displaced forward or aft, and with it the lower ends of the interplane struts to which it is pivoted. The amount of movement is such that the main planes swing through a 0 to 12 deg. arc.

By suitably varying the power, the machine can be flown at a wide range of speeds. The Paul Schmitt airplane can also climb very quickly; it can rise after a very short run with the tail high, a most valuable feature for seaplanes; and, finally, its wings can be made to exercise a powerful braking effect.

Apart from the variable incidence, this machine is interesting on account of the fact that it is built practically throughout of steel. The body is built up of autogenously welded steel tubes. From the nose to a point just behind the seats, it is of rectangular section; to the rear of this the lower longerons converge, thus forming a triangular section. The elevator is very large and partly balanced.

Behind the 160 hp. Le Rhône engine, mounted between double bearings in the bow, are placed the tanks. To the rear of these is the extremely large passenger cockpit, and still farther back is the pilot's seat. In front of him, in addition to the hand wheels mentioned above, are the controls, a wheel operating the ailerons and elevator, and a foot bar for the rudder.

Fog Conditions*

By Major G. I. Taylor

Fogs may be divided into two kinds—those which consist of small drops of water which have been precipitated from vapor in the air, and those which consist of smoke or dust particles and occur only in large towns or in manufacturing districts.

Two conditions are necessary for the formation of a smoke-fog; firstly, the wind velocity near the ground must be very small, so that the air may collect enough smoke to form a fog while passing over the town; and secondly, the air near the ground must be relatively cold compared with the air higher up for a period sufficiently long to collect enough smoke to form a fog.

The relative coldness of the air near the ground has the effect of stopping the formation of vertical currents, which would tend to disperse the smoke upwards. When the air near the ground is cold the fog is therefore confined to a comparatively thin layer close to the ground. This condition confines the occurrence of smoke-fogs to the winter, for it is only at that time that the ground is cold for a sufficiently long period to allow enough smoke to collect to form a fog.

When very light winds occur in the summer, the vertical currents in the daytime carry the smoke into the higher layers, where the wind is usually stronger, so that the smoke gets carried away. Occasionally, however, the wind is very light throughout the whole of the first 6,000 or 7,000 ft. In that case the smoke is carried by the vertical currents during the day up into the upper layers, but it is not carried right away. In this way it forms a haze which is sometimes sufficiently opaque to obscure the sun, though it is nowhere thick enough to be called a fog.

A much more frequent source of fogs is the condensation of water-vapor in the air. The condensation is due either to cooling or to the mixture of two masses of air at different temperatures and containing different amounts of water-vapor.

At any temperature air can only contain a certain proportion of water-vapor. When it has this proportion mixed with it, it is said to be saturated. The amount of water-vapor which air can hold depends on its temperature; the higher the temperature the greater the amount of water-vapor.

A frequent source of condensation is the cooling which takes place in a rising current of air owing to expansion. This is the most frequent cause of clouds. A fog on high land may be due to the forcing up of air from lower-lying land by the contours of the ground, but a fog of this nature is practically the same thing as the lower surface of a cloud into which the high land is projecting. Such a fog would make flying impossible, but even if low cloud did not come right down to the ground so as to form a fog, flying would still be practically impossible.

The chief factor which determines the temperature of the air near the earth's surface is the temperature of the surface; and nearly all fogs, both on land and at sea, are due to changes in the temperature of the earth's surface under the surface air; but there is a great difference between the land and the sea in regard to the way in which this change may take place. Out at sea the temperature of the air seldom differs by more than one or two degrees from that of the sea. The temperature of the sea is only altered very slowly by heat taken from or given to the atmosphere, and there is practically no daily variation in the temperature of the sea surface. The only way in which the temperature of the sea under a given mass of air may alter is by the motion of the air from a place where the sea is hot to a place where it is cold, or *vice-versa*.

In the case of the land, the temperature of the surface of the ground may vary rapidly through a large range. Changes in the temperature of a given mass of surface air are due much more to changes in the temperature of the ground at one place than to movement of the air over ground, the temperature of which varies from place to place. The temperature of the ground depends on a great variety of different causes, such as the amount of cloud (for clouds prevent the ground from cooling at night or heating in daytime), the velocity of the wind, and the temperature of the ground for the last day or two.

The most complicated and, unfortunately, the most frequent cause of fog formation is the cooling of the ground by radiation to the sky at night. This is the kind of fog with which flying men are chiefly concerned.

It is a matter of common observation that fogs occur with light winds or in calms, and that they usually appear when the sky is clear of clouds. This suggests that they are formed during the night on the spot at which they are observed in the morning.

To find out how far this is true and what wind velocity prevents the formation of fog, I examined all the fogs which formed in the night and were observed in the morning at Kew in the five years 1900-1905. This leaves many fogs unaccounted for, because meteorologists make their observations at about 7 a. m., and many summer fogs have cleared off by that time. The wind at Kew is registered by self-recording instruments, and is tabulated every two hours. For convenience I have divided the wind velocities into four classes.

In the first class are included all the occasions when the wind velocity was between 0 and 3.3 m.p.h. The second class contains winds from 3.3 to 5.5 m.p.h., the third winds from 5.5 to 9.2, and the fourth winds from 9.2 to 13.6 m.p.h. At 4 p. m. on the afternoons of the 70 nights on which fog was reported during the period 1900-1905 there were examples of winds of each of the four classes. The actual number of cases in each of the four classes are shown in the first column of figures in Table I. At 6 p. m. the evening calm had set in, and it will be seen on looking at the second column of figures in Table I that there were only two cases in five years in which a wind of 9.2 miles per hour or more at 6 p. m. was followed by a fog during the night. At 8 p. m. the wind had dropped still further on the foggy nights, so that there were only two cases in the five years when a wind of more than 5.5 m.p.h. was followed by fog during the night. At 10 p. m. there were still two cases in the third class, while there were ten cases in the second class.

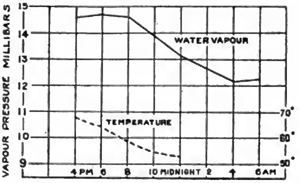


Fig. 1

TABLE I

Frequencies of wind of various strengths at 4 p.m., 6 p.m., 8 p.m., and midnight on the 70 occasions when fog was reported in the night during the years 1900-1905:

Wind Velocity.	4 p.m.	6 p.m.	8 p.m.	10 p.m.	Midt.
0—3.3 m.p.h.	24	35	50	58	62
3.3—5.5 "	23	20	18	10	5
5.5—9.2 "	16	13	1	2	3
9.2—13.6 "	7	2	1	0	0

It will be seen that Table I can be used for forecasting, because if "no fog" had been predicted at Kew every time the wind at 8 p. m. was greater than 5.5 m.p.h., only two mistakes would have been made in five years. We might also have predicted "no fog" every time the wind at 6 p. m. was greater than 9.2 m.p.h., and again we should have been wrong two times in five years; but since there were more occasions when the wind was greater than 5.5 m.p.h. at 8 p. m. than there were when it was greater than 9.2 m.p.h. at 6 p. m., it is evident that we should have made more correct prophecies by using the wind at 8 p. m. than the wind at 6 p. m. That is to say, the 8 p. m. criterion that the wind must be less than 5.5 m.p.h. gives rise to fewer "false alarms," when the possibility of fog is predicted and no fog follows, than the 6 p. m. criterion that the wind must be less than 9.2 m.p.h.

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* Abstract of a paper read before the Aeronautical Society of Great Britain.

Reasoning in the same way, I found, on examining the Kew records, that the wind at 8 p. m. was a better criterion than the wind at 10 p. m. It seems, therefore, that a fog forecaster would do better by observing the wind at 8 p. m. than by observing the wind either before or after that hour.

After rejecting all nights when the wind at 8 p. m. is greater than 5.5 m.p.h., there remain a large number of nights when fog does not form. In many of these cases the sky is covered with clouds. The earth does not cool by radiation under these conditions, and consequently the surface air does not cool either, so that a fog is not to be expected. If, however, all nights when the sky is covered with clouds at 8 p. m., or any later time in the night, be rejected, there still remain many cases of calm, clear nights during which no fog forms. The question which must be looked into is, therefore, why fogs sometimes do form and sometimes do not on calm, clear nights. How is it that on two nights which appear exactly similar fog may form on one occasion and not on the other?

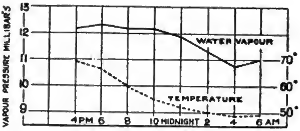

FIG. 2

Two possible explanations at once suggest themselves—either the ground is so warm that the temperature cannot go down enough to produce a fog when the air has the normal amount of humidity or the air is so dry that a fog would only be produced if the fall of temperature during the night were much greater than is usual on calm, clear nights. The first of these is very difficult to deal with, depending as it does on such a complicated series of causes. The second, however, seems to be the more important, which is fortunate, because it is certainly more easy for a forecaster to take account of the dryness of the air than to take account of the conditions which govern the temperature of the ground.

In order to predict whether fog is likely to appear on a calm, clear night, it is first necessary to predict the amount by which the temperature is likely to fall in the night, and then one must measure the amount of water-vapor in the air and find out whether the predicted fall in temperature is great enough to produce a fog.

At first sight the second of these seems to be a question which could be solved by purely physical reasoning. The extreme lightness of a wind during a fog suggests that the occurrence of fog at any place is due to the cooling of the ground in the neighborhood, and not to a mist which has rolled over from somewhere else. When stagnant air is cooled, one might expect the proportion of water-vapor contained in the air to remain constant till the fog begins, when it would decrease, owing to the fact that some of the vapor had been precipitated as drops.

On examining the Kew records I found that on foggy nights the vapor pressure remained constant for a time and then began to decrease. In Fig. 1 will be seen a curve which represents the mean vapor pressure on foggy nights in the summer. It will be seen that this curve shows the characteristic referred to. Taking this as evidence that the vapor pressure remains constant till the fog forms, I next proceeded to calculate how much the temperature would have to drop after 8 p. m. before the air became saturated. I then compared the actual amounts by which the temperatures at Kew had fallen after 8 p. m. on clear, calm nights, and found, to my surprise, that the temperature of the air near the ground falls below the dew-point at 8 p. m. nearly every night when these conditions hold. It is evident, therefore, that the vapor pressure must decrease on non-foggy nights as well as on foggy nights. I examined the clear, calm nights, when fog did not form at Kew, and found, as before, that the vapor pressure of the air near the ground remains constant during the afternoon and evening, and begins to decrease at about 10 p. m.

In Fig 2 is shown the curve which represents the mean vapor pressure on non-foggy nights in summer. The decrease in vapor pressure is evidently due to the deposition of dew on the ground. The cold up-currents which rise from the ground have deposited some of their moisture on the ground, and are therefore drier than the down-currents. When, therefore, the temperature of the air in contact with the ground falls below the dew-point, the vapor pressure of the air above it begins to fall, and the question of whether a fog arises depends on whether mixtures of the up and down-currents are capable of forming fog. If we knew the exact compositions of the up and down-currents, and also the proportions of each in any mixture, we could find out whether fog results by the use of the diagram of Fig. 1.

In order to find out from the known physical properties of air mixed with water-vapor how much below the dew-point at 8 p. m. air must be cooled before fog is produced, we should have to know all about the up and down-currents which transmit the coldness from the ground to the atmosphere, and also all about the vertical distribution of the temperature and humidity.

It is obvious that forecasting cannot proceed on these lines. I have therefore tried to find out a simpler, more empirical method of forecasting. It is well known that the temperature falls more rapidly on warm summer evenings than it does in the winter when it is cold. Suppose that we make observations at 8 p. m. and that we know the average fall in temperature during a calm, clear night for any temperature at 8 p. m. Suppose also that we know how many degrees below the dew-point the air must be cooled before fog forms, then for every temperature at 8 p. m. there will be a certain amount of moisture (or a certain vapor pressure), such that if the air is moister fog is likely, whereas if the air contains less moisture fog is improbable. One could therefore draw a line on a moisture diagram* which has the following property: If the point which represents the state of the air at 8 p. m. lies below it, fog is unlikely during the night, while if the point lies above it, fog is probable.

Now, although we do not know the data by means of which we could construct the line, yet since we know theoretically that such a line should exist we can find it empirically by making all the points representing the state of the air at 8 p. m. on calm, clear nights on the diagram and drawing a line dividing the points which represents foggy nights from those which represent non-foggy nights.

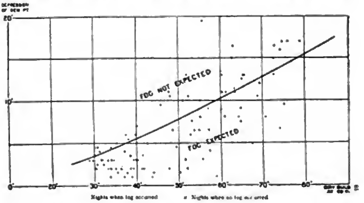

FIG. 3

As a matter of fact, this form of moisture diagram in which the state of the air is represented by a point giving the vapor pressure and the temperature is not very convenient.

Vapor pressure is not, as a rule, measured directly. The most convenient way of measuring the amount of water-vapor in the atmosphere is to measure the difference in temperature between a dry thermometer and one whose bulb is kept wet by being covered by wet muslin. When the air is dry there is considerable difference in temperature between the wet and dry bulbs, owing to the cooling of the wet bulb by evaporation. When the air is saturated the water does not evaporate from the wet bulb. The wet bulb is therefore not cooled below the temperature of the dry bulb. The difference between the temperatures of the wet and dry bulbs therefore measures how far off the air is from saturation. Tables have been drawn up showing the vapor pressure and depression of the dew-point † for various temperatures of the wet and dry bulb thermometers.

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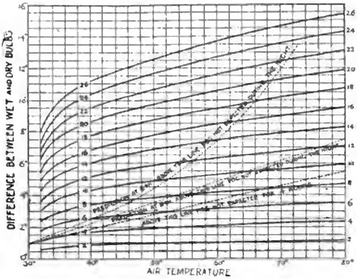
* A diagram which shows the vapor-pressure and temperature of the air.

Using these tables, I took every case in which the wind and cloud conditions at 8 p. m. at Kew were suitable for the formation of fog, *i.e.*, every case in which the wind was less than 5.5 m.p.h. and the sky was not covered with clouds, and found the depression of the dew-point. I then marked each of these on a diagram representing the state of the air by points, giving the temperature as abscissa and the depression of the dew-point as ordinate. For every night when fog occurred I marked the point as a round dot, and for every night when no fog was reported I marked a cross. The diagram is shown in Fig. 3. I then drew the line shown in the figure which divides roughly the dots from the crosses. It will be seen that there are only three dots above the line, while there are 31 crosses. If, therefore, this line had been used for forecasting, on occasions when the wind and cloud conditions were suitable for fog, that no fog would occur if the point representing the state of the air at 8 p. m. were above the line in the diagram, three mistakes would have been made for 31 correct predictions. On the other hand, when the point lies below the line, the chances are about equal that a fog will occur at Kew and that it will not.



It appears, therefore, that a diagram of this form should be of some use in predicting the occurrence of fog if it applies to other places besides Kew. I find on examining the records of Oxford, Nottingham and Potsdam, that the line is in each case very close to the Kew line.

As the diagram stands, it is not very convenient to use, because, after reading the wet and dry bulb thermometers, one has to look up in a table to find the depression of the dew-point. It can be made more convenient by transferring the line to a diagram in which the state of the air is represented by a point showing the difference between wet and dry bulb readings as ordinate and the temperature as abscissa.

A diagram constructed on this principle is shown in Fig. 4. The line shown in Fig. 4 was transferred from Fig. 3 by finding, from the tables, the difference between the wet and dry bulb readings corresponding with points in Fig. 3. The diagram may be used conveniently for predicting whether fog is likely to appear on an aerodrome or not during the night. The wet and dry bulb readings are taken at 8 p. m. If the wind is less than 5.5 m.p.h. and if the sky is not completely covered with clouds, then a fog is probable if the point on the diagram which represents the state of the air at 8 p. m. lies below the line. If the point lies above the line, fog is improbable.

If the point lies close below the line, *i.e.*, if there is still a considerable difference between the wet and dry bulb readings, but not enough to ensure the absence of fog, fog is probable, but since the air is still unsaturated fog will not appear for some time after the readings were taken. A difference of more than a degree between the wet and dry bulb readings may be taken to indicate that fog will not appear immediately. A line has been drawn on the diagram which indicates roughly the difference which is necessary in order that fog may not appear for about four hours. This line evidently lies below the other line, and points which lie between the two indicate the probability that fog will form after midnight. It seems possible that the diagram may be of some use to flight-commanders in telling night pilots how long to stay up.

It may sometimes be convenient to make a forecast at 6 p. m. instead of at 8 p. m., though for reasons already given the 8 p. m. forecast is more likely to be correct. To allow for this contingency a third line has been drawn on the diagram above the 8 p. m. line. When the point representing the state of the air at 6 p. m. lies above this line, fog is improbable during the night.

The chance that a prediction made with this diagram will be right can be judged by looking at the diagram of Fig. 3, but there is another cause which limits its usefulness in the winter, the freezing of water which is supplied to keep the wet bulb from becoming dry. When this water freezes the readings of the wet bulb become unreliable. In the summer, however, the use of the diagram should lead to a considerable improvement in forecasting the occurrence of a radiation fog.

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† The depression of the dew-point is the number of degrees through which the air must be cooled before dew is deposited.

Book Review

"AIR NAVIGATION FOR FLIGHT OFFICERS," by A. E. Dixie, R. N. (D. Appleton & Co., New York, $4.00. 223 pp.)

This book contains condensed information on the subject of aerial navigation. The subject matter is presented in a clear manner, and can be easily followed.

The author commences by giving a summary of the laws of magnetism, and applies these laws to the magnetic compass. The compass is then taken up, its construction and its mode of operation described. The errors of the compass and methods of allowing for these are then considered, and finally the method of obtaining bearings and correcting bearings is taken up.

The first five chapters are devoted to a discussion of the laws of magnetism, the compass, and the use of this instrument. The next three chapters deal with weather observations. In these chapters the author explains cloud and fog formations, weather charts, storm signals, and weather forecasting. Under the head of weather forecasting are given simple and useful rules for the forecasting of weather without the use of any instruments.

The ninth chapter deals with astronomy, and the methods employed in finding the time of sunrise, sunset, moonrise, moonset, etc. The more important constellations are pointed out by means of sketches, and the practical use of these constellations in making observations is dealt with.

In the tenth chapter Mr. Dixie goes into the theory of the construction of charts, and the method of using charts for obtaining a course, and finally gives some rules for obtaining the distance covered by an airplane when being drifted by the wind.

In the last three chapters Mr. Dixie explains the use of protractors, and gives examples in determining the course to be steered in order to intercept a hostile ship, the method employed in fixing positions, and the use of maps with conventional markings.

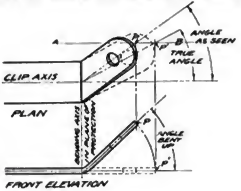
The Design of Airplane Fittings

By Randolph F. Hall

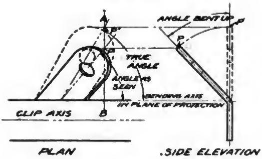
of the Thomas-Morse Aircraft Corp.

The design of proper fittings for aeronautical use is one of the most important constructional details of the entire airplane. Nothing destroys the appearance of a finished machine more than a fitting out of angle. Fittings must not only be strong, but light and simple, and exposed clips of such design as to reduce head resistance to a minimum.

To any one not familiar with the work, the development of fittings in the flat pattern is often an intricate problem and has been the cause of undue expense and poor design. The graphical methods illustrated in appended sketches of solving true angles for flat pattern may be of value to the drawing-room, inasmuch as the method is easy to comprehend, sufficiently accurate and required but little time.



CASE I



CASE II

CASE I.—Bending Axis Perpendicular to Clip Axis.

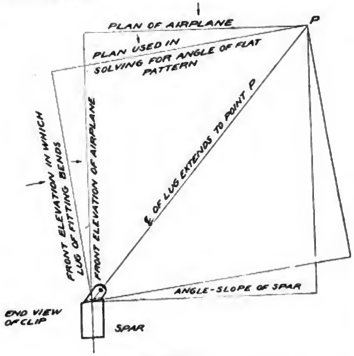
Let P be any point on lug centerline.

Projecting lug to flat plane P describes arc to P'.

In plan P will always lie in plane A B, which is perpendicular to bending axis, and to correspond to front elevation P moves to P', thus forming true angle, as shown.

CASE II.—Bending Axis Parallel to Clip Axis.

Same procedure as with Case I, using side elevation instead of front elevation.


PLAN OF AIRPLANE
P
PLAN USED IN SOLVING FOR ANGLE OF FLAT PATTERN
℄ OF LUG EXTENDS TO POINT P
FRONT ELEVATION IN WHICH LUG OF FITTING BENDS
FRONT ELEVATION OF AIRPLANE
ANGLE-SLOPE OF SPAR
END VIEW OF CLIP
SPAR

CASE III

CASE III.—To Find Flat Pattern Angle of Fitting of Case I or II if Set on Sloping Spar.

Same procedure as for Case I or II, correcting plan and front elevation as indicated in diagram.

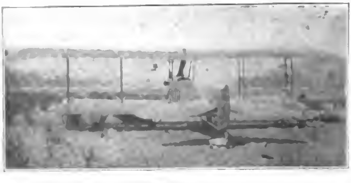
The Kyle Smith Sporting Airplane

The Kyle Smith Aircraft Company is producing a light sporting model for cross-country flying and for exhibition work. Views of the machine are shown in the photographs. The main data for the machine are as follows:

Span, top, 32 ft.; spleet, bottom, 22 ft.; length overall, 20 ft. 9 in.; chord, 4 ft. 6 in.; gap, 4 ft. 6 in.; main supporting surface, 245 sq. ft.; stabilizer, 18 sq. ft.; elevators, 18 sq. ft.; rudder, 8 sq. ft.; fin, 3 sq. ft.; wing section, R. A. F. 6; main planes are staggered 20 per cent.; dihedral angle 2½ deg.; control, Deperdussin; wing flaps, 16 sq. ft. each; speed range, 35 to 65 miles per hour; total weight, empty, 600 lb.

The airplane is of standard design, with a rather big overhang on the upper plane; by screwing two turnbuckles the overhang can be let down, and the machine will then go through a space of 22 feet. To eliminate warping, tail surfaces are made of steel tubing.

FRONT VIEW



REAR VIEW

Simplified Method of Propeller Calculation

In a paper called "The Screw Propeller in the Air," read by M. A. S. Riach on March 21 before the Aeronautical Society of Great Britain, the author developed an analytical theory of the air screw, which was based on empirical results obtained from aerofoil data such as were first enunciated by by S. Drzewiecki, and later amplified by F. W. Lanchester in his work, "Aerial Flight."

The investigation of Mr. Riach and the new theory based upon it brought forth a number of main points which are the following:

(1) The importance of high aspect ratio, that is multiple blades.

(2) Good sections having high lift-drag values as aerofoils.

(3) Correct values for maximum efficiency.

(4) Wide blades to be employed in conjunction with the correct chord angles for best efficiency.

(5) Some uncertainty as to the correct amount of end tip loss to be allowed for.

(6) Multiple bladed air screws should, if the new theory is correct, require more brake horsepower than their two-bladed equivalents under similar conditions, but they should develop a greater thrust at the same forward and rotational speed, and their efficiency should be higher.

(7) Multiple blades raised the question of the requisite strength and consequent area of the sections from boss to tip, which cannot be decreased indefinitely without fear of bursting taking place. Advantage may, however, be taken from the fact that a very slight forward rake is usually sufficient to convert the whole stress into pure tension and consequently a much smaller section can then be employed. It should, however, be noted that the center of area of the blade sections along the blade should not in general lie on a straight line, but on a curve, the determination of which may be accomplished as a rule without much difficulty. All the sections will then be stressed in pure tension.

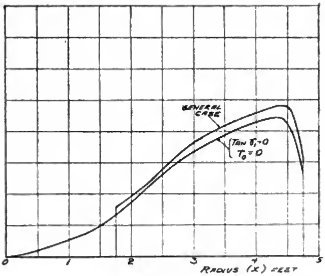


FIG. 1

In order to reduce this theory for purposes of design work in the drawing office, Mr. Riach recently published in *Aeronautics* the following simplified method of propeller calculation:

The formula previously obtained for the blade constant (C_1) is given by:

$$C_1 = \frac{550.\,H}{8.\pi^2.n^2.N.\rho.\;{}_{r_0}\!\int^{r} Cy_1.f(x).x^2.\sec.A_1.\,(\tan A_1 + \tan\gamma_1)\,dx.}$$

Now, if V_1, the inflow velocity, is made constant for all radii, *x*, the above integral reduces to a simple form.

The substitution:

$$f\,(x) = \frac{4.\pi.x.\sin A_1.(\tan A_1 - \tan A).}{N.C_1.Cy_1.(1 - \tan A_1.\tan\gamma_1)}$$

being made and inserted for $f\,(x)$ in the integral given above.

The integral then becomes:

$$I = \frac{2_1.V_1.(V + V_1)}{N.C_1.2.\pi.n^2}\cdot{}_{r_0}\!\int^{r}\frac{x^2.[V + V_1 + 2\pi.n.x.\tan\gamma_1].dx.}{2\pi.n.x. - \tan\gamma_1.\,(V + V_1)}$$

Upon examination we see that as $\tan\gamma_1$ is decreased the value of I also decreases.

Again, as r_0 decreases from some positive value toward zero, the value of I increases. [Note.—r_0 is usually a small positive fraction of r.]

Hence, if both $\tan\gamma_1$ and r_0 are made equal to zero, the value of I may not change appreciably as these two effects tend to neutralize each other. This is shown clearly in Fig. 1, representing the two integrals plotted graphically.

We shall then first find the value of I in the general case, when $\tan\gamma_1$ and r_0 have any values whatever, and then find the value of I when both of these quantities have a zero value.

By equating the two expressions we shall obtain the values of $\frac{r_0}{r} = K$, say, which must be satisfied if the complete integral is to have the same value when both r_0 and $\tan\gamma_1$ are zero.

This procedure leads to the following formula for K:

$$\frac{r^3}{3}.(1 - K^3).\tan\gamma_1 - \frac{K^2.r^2.(V + V_1)}{4\pi.n} + \frac{r.(1 - K).(V + V_1)^2}{4.\pi^2.n^2} + \frac{(V + V_1)^3}{8.\pi^3.n^3}.\tan^2\gamma.\log\frac{r - \dfrac{(V + V_1)}{2.\pi.n}.\tan\gamma_1}{Kr - \dfrac{(V + V_1)}{2.\pi.n}.\tan\gamma_1} = 0$$

A graph of K against $(V + V_1)$ is given in Fig. 2 for several diameters, and $\tan\gamma_1 = \frac{1}{20}$, $n = 20$.

It is seen that an average value of K is thus about .6, which is certainly rather high, and for an 8-ft. diameter airscrew r_0 would then be 2.4 ft.

Decreasing $\tan\gamma_1$ will decrease K.

The value of the integral when both $\tan\gamma_1$ and r_0 are zero is:

$$I_0 = \frac{V_1.(V + V_1)^2.d^2}{16.\pi^2.n^3.N.C_1}$$

whence:

$$C_1 = \frac{550.H.16.\pi^2.n^3.N.C_1}{8.\pi^2.n^3.N.\rho.V_1.(V + V_1)^2.d^2}$$

which gives:

$$V_1.(V + V_1)^2 = \frac{1100.H}{\pi.\rho.d^2}$$

from which the value of (V_1) may be found very simply for any given values of the other parameters, H, V, d.

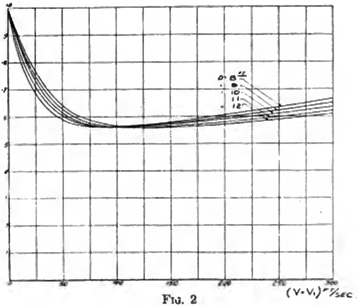


FIG. 2

Now the same result may be obtained from R. E. Froude's theory direct, *i. e.*, without the aerofoil theory at all.

The change in kinetic energy per sec. is:

$$\tfrac{1}{2}.M.[(V + 2.V_1)^2 - V^2] = \tfrac{1}{2}.M.[2.V + 2.V_1].2.V_1$$
$$= M.[V + V_1].2.V_1$$

and M = Mass/sec. through the airscrew $= \frac{\pi}{4}.d^2.(V + V_1).\rho$

and ∴ Change in K.E./sec. $= 2 \,.\, V_1 \,.\, (V + V_1)^2 \,.\, \frac{\pi}{4} d^2 \,.\, \rho$

Hence, B.H.P. necessary is given by:

$$H = \frac{2 \,.\, V_1 \,.(V + V_1)^2 \,.\, \pi.d^2.\rho}{4 \,.\, 550}$$

$$= \frac{V_1 \,.\, (V + V_1)^2 \,.\, \pi.d^2 \,.\, \rho}{1100}$$

which gives

$$V_1 \,.\, (V + V_1)^2 = \frac{1100 \,.\, H}{\pi.d^2 \,.\, \rho}$$

the same result as before.

Having thus found V_1, which is to be constant for all radii x, we proceed to find the value of C_1 and hence of $C_1 \,.\, f(x)$—*i.e.*, the blade width at any radius x.

Returning to the formula, already employed in the substitution for $f(x)$, we see that:

$$C_1 \,.\, f(x) \,.\, Cy_1 = \frac{4.\pi.x \,.\, \sin A_1 \,.\, (\tan A_1 - \tan A)}{N \,.\, (1 - \tan A \,.\, \tan \gamma_1}$$

Now $\tan \gamma_1$ was taken to be zero, so that:

$$C_1 \,.\, f(x) \,.\, Cy_1 = \frac{4.\pi.x \,.\, \sin A_1 \,.\, (\tan A_1 - \tan A)}{N}$$

which may now be plotted graphically against (x), since $A_1 = \tan^{-1}\left(\frac{V + V_1}{2\,\pi.n.x}\right)$ and V_1 has been previously found.

We thus obtain a graph of the form given in figure (3), which shows the value of the product $C_1 \,.\, f(x) \,.\, Cy_1$ for any radius x.

[NOTE.—V_1 is actually *made* to have a constant value across the "disc," and hence this is *not* to be regarded as an approximation.]

It is then open to the designer either to vary $f(x)$ or Cy_1 so that the product of the two shall be *proportional* to the ordinates on the curve at any radius chosen.

Having thus by a tentative process found suitable values for $f(x)$ and Cy_1 along the blade, we can, knowing the sections to be employed at the various radii, find from the wind-channel results the corresponding values of α_1, the angles of attack of these sections, corresponding to the Cy_1 values chosen for these radii.

It only remains then to fix the angles to the plane of rotation ϕ along the blade. This can be done at once from the relation:

$$\phi = \alpha_1 + \tan^{-1}\left(\frac{V + V_1}{2\,\pi.n.x}\right)$$

In estimating the probable *efficiency* of the airscrew, it will be necessary to employ the *complete* formula occurring in the numerator in the general efficiency expression, since same is a measure of the thrust of the screw, and the same conditions regarding $\tan \gamma_1$ and r_0 do not apply. This is evident from a consideration of the thrust integral:

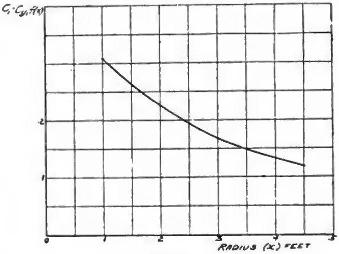


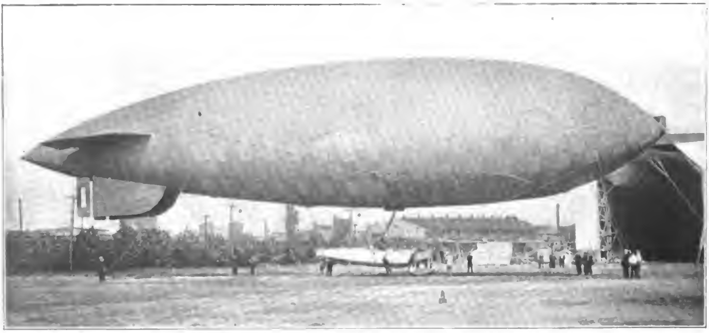
FIG. 3

$$\int_{r_0}^{r} Cy_1 \,.\, x^2 \,.\, f(x) \,.\, \sec. A^1 \,.\, (1 - \tan A_1 \,.\, \tan \gamma_1) \,.\, d\,x,$$

when it is evident that decreases of $\tan \gamma_1$ and r_0 do *not* neutralize each other, the value of the integral becoming *larger* as r_0 is decreased, $\tan \gamma_1$ does not enter into the formula when the value of $f(x)$ is substituted in the integral.

A New American Coast Patrol Airship

Within the past week the Navy Department has accepted for harbor and coast patrol service a 100 hp. airship of the non-rigid type. The vessel, illustrated herewith, took four months to build. The trials, which the manufacturer states were entirely satisfactory, comprised among others an endurance run of eight hours, which took place over a large town "somewhere in America." The airship is here shown preparatory to making a trial ascent.



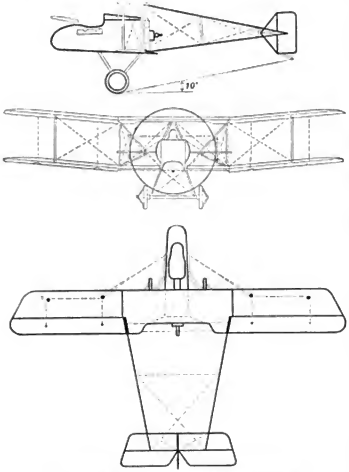
A NEW 100 HORSEPOWER NAVAL BLIMP

Digest of the Foreign Aeronautical Press

Flight (London), September 6, 1917

The De Havilland Single Seater Fighter.—According to the German aeronautical magazine *Flugsport* the De Havilland fighter, which the Royal Flying Corps extensively used during 1916, has the following characteristics:

The machine is a pusher biplane of equal span and carries the steering gear on outriggers of the Maurice Farman type. The planes consist of three sections; the center section has a span of 11½ ft. and to this the lateral sections are attached at a dihedral angle. There are two pairs of interplane struts on each side; the tail booms are attached to the internal after struts. The ailerons are held flush with the trailing edge by rubber cords on the upper surface. The armament consists of a machine gun mounted on a pivot in front of the pilot.



THE DE HAVILLAND SINGLE SEATER FIGHTER

CHARACTERISTICS

Span, upper and lower	31 ft. 5 in.
Chord, upper and lower	4 ft. 0 in.
Overall length	22 ft. 8 in.
Height	9 ft. 4 in.
Area, upper plane, with ailerons	115.2 sq.ft.
Area, lower plane, ailerons	103.3 sq.ft.
Area, total supporting	218.5 sq.ft.
Area, each aileron	15.8 sq.ft.
Area, elevators	12.8 sq.ft.
Area, rudder	7.2 sq.ft.
Stagger	None
Retreat	None
Incidence, upper and lower plane	4 deg. 30′
Incidence, stabilizer	0.8 deg.
Power plant	100 hp. monosoupape Gnome
Propeller (diameter)	7 ft. 8 in.
Speed, horizontal	93 m.p.h.
Gross weight	1047.2 lb.
Useful load	541.2 lb.
Total weight, loaded	1588.4 lb.
Lift loading	7.3 lb./sq.ft.
Power loading	15.9 lb./hp.

Tungsten from South Africa.—The great increase in the cost of the high-speed steel employed in the making of machine tools reminds one that there are large deposits of tungsten in Southern Rhodesia, at Essexvale. Although mining operations have not as yet been undertaken there on a large scale, there has been some desultory work on the alluvial or rubble wolframite and this appears to have given rise to the idea that the deposits were only alluvial. There are, however, sixteen distinct reefs known and eleven of them have had a little work, a few feet below the surface, done on them from time to time.

In the two years after 1906, when the deposits were first prospected, a fair amount of ore was produced, but production ceased in 1909 and was not resumed for three years. Altogether about eighty-five tons of concentrate, valued at $35,825, has been marketed. The returns for 1916 are 2½ tons, valued at $2,335, which was produced by one worker with a few natives in a 5 ft. rotary diamond washer, and by one man on another claim, who hand picked rubble and recovered 1600 lb. of wolframite.

Allied and German Airplane Losses.—Enemy claims of Allied airplane losses and admissions of their own losses during the three first years of the war are disclosed in the accompanying tables, taken from German publications. It is needless to add that the Allies' version of the comparative losses suffered in warfare would tell quite a different story for, whereas the Allies count as "destroyed" only such craft as are reported by several observers to have crashed, the enemy lists as his victory every Allied machine that is driven down "apparently out of control," such as a nose dive or a tail spin. It is well to remark that the latter maneuvers are often employed by aviators in order to escape overwhelming odds and can, therefore, by no means be taken as indicating the loss of a machine.

The detailed enemy claims for Allied and German airplane losses for the three first years of the war are as follows:

	German	Allies
First year (1914-15)	47	72
Second year (1915-16)	173	455
Third year (1916-17)	462	1,771
Total	682	2,298

Air Fighting in August.—The British and French communiqués, published during August, show that 179 enemy airplanes and nine enemy balloons were brought down, and 118 enemy airplanes and two enemy balloons driven down. The Germans during August claim to have shot down 131 Allied airplanes and 15 Allied balloons. Eighty-six British machines are reported by our headquarters as missing. The French give no particulars as to losses and the Germans announce the loss of only five airplanes. In August, Guynemer had his fiftieth air victory and was elected an officer of the Legion of Honor. The Germans claim that in this month their "Chasing Echelon No. 4," under Capt. Richthofen, brought down its two-hundredth adversary. Eight raids by R. N. A. S. on points in Belgium are recorded.

BRITISH REPORTS

Enemy machines brought down	106
Enemy machines brought down out of control	83
British machines missing	86
Enemy balloons brought down	2
Enemy balloons driven down badly damaged	2

FRENCH REPORTS

Enemy machines brought down	73
Enemy machines driven down in their own lines	35
Enemy balloons brought down	5

GERMAN REPORTS

British, French or Belgian machines shot down	131
German loss of machines admitted	5
Allied balloons brought down	15

Aeronautics (London), August 29, 1917

The Curtiss OX-5 Aero-Engine.—This new engine resembles in the main the well-known OX-2 model. The following modifications have, however, been incorporated:

The upper half crankcase has been stiffened by extra ribs, and is being made of heavier metal. Improvements have been effected in the main bearing. The magneto bracket has been stiffened. New design breather pipes have been fitted, which result in even more economic oil consumption. The Berling D-81 magneto, of more substantial design than the A-81, is now being used. The water pump support is of more rigid construction.

Oil slingers are now fitted at each end of the crankshaft; and also a new oil strainer, which allows the screen and the oil reservoir to be examined without disassembling the lower half of the crankcase. An improved oil level indicator has also been fitted, and a new auxiliary air valve which permits of much better functioning of the engine at low speeds and is lighter in weight. Detail improvements in the valve action have also been incorporated.

Aeronautics (London), September 5, 1917

R. H. Barnwell Dead.—R. H. Barnwell, one of the greatest pioneers of British aviation, was killed on Aug. 27 in an aviation accident near Dartford. Barnwell was flying a fast scout that had been previously flown the same day. After several loops, he spun the machine and came out, but on repeating the evolution he spun straight into the ground and was immediately killed. The witnesses came to the conclusion that Barnwell must have fainted, as he did not make any attempt to recover himself.

Barnwell was thirty-eight years old at the time of his death. He was a brother of F. S. Barnwell, designer to the British and Colonial Aeroplane Co. of Bristol, and author of "Aeroplane Design."

After having built, in 1908, an experimental monoplane, and in the following year a large biplane, Barnwell took his pilot certificate at Brooklands and eventually joined Vickers, Limited, remaining with that firm up to the time of his death, first as manager of their Brooklands airdrome and later as testing pilot.

Flight (London), August 30, 1917

Parachutes for Airmen. (Editorial.)—We have before us certain correspondence on the subject of the training of airmen in the use of the parachute as a means of life saving.

We had almost decided to refrain from commenting upon it but for the statement that during the last raid on the coast an enemy airman made use of a parachute to escape from his machine when it was brought down in aerial combat. We know the uses of the parachute in free and captive ballooning, but its adaptability for use in airplanes is more uncertain, principally for the reason that it is next door to impossible to carry out the necessary experiments to ascertain precisely what its measure of use may be.

The suggestion in the correspondence, to which we have referred, is that training classes should be established to teach the use of the parachute. In the abstract, the idea is excellent and we agree that the question is well worthy of very careful examination.

As we are well aware, the toll of life in the Air Services under conditions of active service is exceedingly heavy and there can be no manner of doubt that, provided some such device as the parachute can be adapted to use from a fast flying or falling aeroplane, the actual loss might be substantially reduced. There is, however, a decided question whether it is really possible to demonstrate its use under such circumstances as a part of the curriculum of training. We are very much inclined to think that the risks would be far greater than could possibly be justified. The way the matter appeals to us is that to leave an airplane by parachute is absolutely the very last resource of the airman who finds himself in extreme difficulty . . . it supplies him with the off-chance of saving his life.

Now, to be really effective the training in its use would have more or less to reproduce those circumstances of extreme difficulty, and it is perfectly obvious that no sane commander or administration would consent to the necessary risks being taken. The fact that a German airman appears to have made use of such a device, and apparently with success, establishes a case for enquiry and, within limits, of experiment, but we should scarcely like to go so far as to say that instruction in the use of the parachute should as yet form a part of the ordinary course of training of aviators.

Novelties in Fuels, and Their Use.—A novel method for starting and running internal combustion engines, which is the patent of F. E. Smith and Vickers, Limited, has lately been applied to automobiles, though at the moment the aircraft engine is outside the range of its application.

The fuel is a composition of various ingredients, one mixture being forty-one parts potassium nitrate, forty-one parts charcoal and eighteen parts sulphur, with sufficient moisture to make it plastic. Not the least important feature of the scheme is that by which only partial combustion is secured in the first cylinder, the residue of energy being utilized in the second cylinder by the addition of air or oxygen, the process being repeated continuously. For starting purposes, by igniting a cartridge of the fuel a reservoir can be immediately charged with gas at high pressure, which can be used for the engine.

Flying (London), August 29, 1917

The Handicap of the Wind. By F. W. Lanchester.—A scientific explanation of the work of the wind in its relation to aerial operations on the Western front. As the prevailing winds blow from the Western quarter during the greater part of the year, it becomes self-evident that the wind works for the enemy machine in the case of engine trouble because it lengthens the path of its volplane and thus enables it to reach in most cases its own lines, whereas an Allied airplane suffering a breakdown will find its gliding path so shortened that the aviator will mostly have to land in No Man's Land, if he does not come down within the enemy lines. The work of the wind should, therefore, be taken into account when comparisons are made between Allied and enemy airplane losses.

The Immelmann Turn.—A favorite maneuver of enemy fighter airplanes is the so-called Immelmann Turn. This is in the main made use of when the German wants to out-maneuver an Allied aviator who has obtained a favorable position for attack behind and beneath the enemy's tail.

THE IMMELMANN TURN

Courtesy of Flying (London)

The Immelmann Turn consists essentially of three distinct phases: first, the *turnover*, in which the machine is pulled over onto its back by use of full right or left aileron and opposite ruddering; second, the *nose dive*, and third, the *recovery*, which leaves the machine flying in exactly the opposite direction to its initial flight path. In doing the Immelmann Turn the pursuer invariably overshoots his mark and finds himself, at the completion of the maneuver, at a considerably higher altitude than his opponent. The accompanying illustration depicts the second phase of the Immelmann Turn.

The Aeroplane (London), August 22, 1917

The Production of Aeroplanes and their Components. By Stepney Blakeney. (Tenth Instalment.)

Aero-Motors in Kind and Construction. By Geoffrey de Holden-Stone.

News of the Fortnight

Aircraft Board Bill Is Sent to President

The bill authorizing the creation of an Aircraft Board was passed by the Senate on Sept. 12, as reported with amendments by Senator Sheppard, Chairman of the Committee on Military Affairs, and on Sept. 27, the Senate agreed to the House amendments officially creating an Aircraft Board, without sending the measure to conference. The bill has been sent to the White House to receive the President's signature.

This bill was originally introduced into the Senate by Senator Sheppard and into the House by Congressman Murray Hulbert, under the title of the Air Board Bill. Amendments were made in the Senate that involved minor modifications and changed the title to Aircraft Board. The bill follows.

A BILL

To Create the Aircraft Board and Provide for Its Maintenance

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that for the purpose of expanding and coordinating the industrial activities relating to aircraft or parts of aircraft produced for any purpose in the United States and to facilitate generally the development of air service, a board is hereby created to be known as the Aircraft Board, herein after referred to as the board.

The board shall be composed of the Chief Signal Officer of the Army, the Chief Constructor of Navy, and not more than seven other members of recognized capacity and achievement along industrial lines to be appointed by the President, by and with the advice and consent of the Senate.

The board shall elect one of its civilian members as president thereof, and said board and tenure of office of the members thereof shall continue during the pleasure of the President, but not longer than six months after the present war. The civilian members of the board shall receive a compensation of $7,500 each per annum.

The board is hereby empowered to supervise and direct, in accordance with the requirements prescribed or approved by the Departments of War and Navy, respectively, the purchase, production, and manufacture of aircraft, engines, and all ordnance and instruments used in connection therewith, and accessories and materials therefor, including the purchase, lease, acquisition, or construction of plants for the manufacture of aircraft, engines, and accessories.

The board is also empowered to employ, either in the District of Columbia, or elsewhere, such clerks and other employes as may be necessary to the conduct of its business, including such technical experts and advisers as may be found necessary, and to fix their salaries. Such salaries shall conform to those usually paid by the Government for similar service: *Provided*, That by unanimous approval of the board higher compensation may be paid to technical experts and advisers. The board may rent suitable offices in the District of Columbia or elsewhere, purchase necessary office equipment and supplies, including scientific publications and printing, and may incur necessary administrative and contingent expenses, and for all of the expenses enumerated in this paragraph there shall be allotted by the Chief Signal Officer of the Army for the fiscal year nineteen hundred and seventeen and nineteen hundred and eighteen the sum of $100,000, or so much thereof as shall be necessary, from any appropriation now existing for or hereinafter made to the Signal Corps of the Army, and such appropriation is hereby made available for these purposes: *Provided*, That, except upon the joint and concurrent approval of the Secretary of War and the Secretary of the Navy, there shall not be established or maintained under the board any office or organization duplicating or replacing, in whole or in part, any office or organization now existing that can be properly established or maintained by appropriations made for, or available for, the military or naval services.

Large Italian Airplanes Fly to Washington

Three Italian airplanes flew from Langley Field to Washington, D. C., on Saturday, Sept. 21.

The 120-mile trip was made without mishap by the Pomilio and the Caproni machines, which made good time, but the other battleplane, an S. I. A., equipped with a Fiat engine, although the first to arrive over Washington, either ran out of gasoline or experienced some engine trouble and was forced to land in a marsh just south of Washington on the Virginia side of the Potomac, where it stuck. Lieutenant Ballerini and his observer, Lieutenant Abbetti, were uninjured.

About 11.15 the first Italian battle-plane, the 300 hp. Pomilio which was piloted by Lieutenant Baldioli of the Italian Army, was sighted. Although the third machine to leave Newport News, this was the first to arrive in Washington.

The giant Caproni biplane, powered by three 175 hp. engines, driving two tractor screws and a pusher propeller, carrying ten passengers, put in its appearance about 11.35 at a very great height. After circling about for a few minutes the pilot, Lieutenant Resnati, began to spiral down slowly.

Lieutenant Resnati made a beautiful landing, and presently his passengers and mechanics began climbing out. Among the former were Dr. William F. Durand, chairman of the National Advisory Committee for Aeronautics; Dr. Samuel W. Stratton of the Bureau of Standards, and also a member of the Advisory Committee; W. B. Stout; official photographer Erricsson; H. J. Kubel of the Geological Survey, and Captain Tappi of the Italian Army.

New American Altitude Records

Caleb Bragg, an aviator cadet in the United States Army Air Service, ascended on Sept. 19 at Hazelhurst Field to an altitude of 22,000 ft., thus establishing a new American altitude record for airplanes. Bragg used a Wright-Martin model V biplane fitted with a 150 hp. Hispano-Suiza engine built by the Simplex Works of New Brunswick, N. J.

WRIGHT-MARTIN MODEL V BIPLANE

Passed by Committee on Public Information

The flight for the altitude record of seaplanes, with pilot and two passengers, was made August 25 in a Wright-Martin flying boat, with a Hispano-Suiza engine. A height of 12,900 feet was reached.

The previous American seaplane record for pilot and two passengers was 9,524 feet, and the present American seaplane record for aviator and one passenger is 12,333 feet. This record has been allowed by the Aero Club of America.

Y. M. C. A. School for Air Mechanics

Mechanics who wish to do their "war bit" while working at their own trade are eligible, if in fit condition, to learn airplane mechanics and qualify as non-commissioned officers in the aeronautical service. They will not be expected to fly, but to take care of the airplane engines and the planes under direction of officers.

A school to train airplane mechanicians will be opened in a few days by West Side Y. M. C. A., 318 West Fifty-seventh street, New York, and the army will doubtless enlist all the graduates who can pass the required tests.

The school will be under the direction of F. S. Gostenhofer and will be assisted by a corps of instructors. The course will include thorough instruction in the mechanics of the airplane and its engine. The aero school will be under the general supervision of H. Clifford Brokaw, head of the West Side Y. M. C. A. Automobile School, which has turned out more than 15,000 automobile drivers and mechanics.

Captain Guynemer Lost

Capt. George Guynemer, the famous French aviator, is believed to be dead.

He met his death, it is supposed, in a reconnaissance flight over Flanders on which he left Dunkirk Sept. 11. Nothing has been heard of him since and it has been assumed that he was lost. French Army Headquarters issued on Sept. 25 a confirmatory report.

Captain Georges Guynemer
Photo American Press Assn.

Captain Guynemer, who attained world wide fame by his exploits, was perhaps the most brilliant aviator of the war. He was last cited in the official French announcement of September 10 for having won his fiftieth aerial victory. An unofficial press dispatch a few days earlier said he had accounted for fifty-two enemy machines. He was 21 years old.

Only a little more than two years ago Capt. Guynemer was a simple soldier. He entered the French Army as a volunteer after having been rejected five times by the medical inspectors. Joining the Aviation Corps, he rose rapidly in rank until he attained the grade of Captain, winning the Cross of the Legion of Honor, the Military Medal, the War Cross, and almost every other honor which his country could bestow.

The young aviator took part in many spectacular flghts, and had the narrowest escapes on several occasions. In March of last year he was wounded.

One of the most spectacular achievements of Capt. Guynemer was the shooting down of three German airplanes in two minutes and thirty seconds in September, 1916. On one occasion he was forced to descend between the French and German trenches, but was able to escape.

Guynemer operated his airplane alone, serving as both pilot and gunner.

Non-Stop Flight from Turin to Rome

Captain Marchese Giulio Laureati, of the Italian Royal Flying Corps, who established on Aug. 29 last a new world's aviation distance record in circuit by flying from Turin to Naples and back without a stop, a distance of 920 miles, made on Sept. 25 another remarkable nonstop flight, which took him in a straight line from Turin to Rome.

Captain Laureati left Turin at 8.28, Italian time, and landed at Hounslow at 2.50 in the afternoon, having completed a journey of 656 miles in 7 hr., 22 min., 30 sec.

Captain Laureati flew an Aila machine and carried a mechanic as passenger and two machine guns.

From Turin he followed the railway as far as Susa, on the Italian frontier. Crossing the Alps by Mont Cenis at an altitude of nearly 12,000 ft., he passed over Lanslebourg and rejoined the railway at Modane. During the crossing of the Alps he encountered rough weather, and throughout the whole journey had to face a strong northwesterly wind.

From Modane, still following the line of railway, the aviator traveled northwest to Culoz, which he reached in an hour and forty minutes from Turin, and, continuing on the same line, passed over Verdun-sur-le-Doubs. He crossed the Cote d'Or Department and proceeded by way of Flavigny and Bussy across the Department of Seine et Marne, passing to the east of Paris and completing his transit of France by way of Compiègne, Amiens, and Cap Gris Nez.

Throughout this part of the journey he kept an average height of about 9,900 ft. He crossed the Channel in 15 min., dropped to 2,000 ft. to pick up his bearings, and completed his journey to Hounslow without misadventure except for a slight detour made in error over Hendon.

He carried with him in addition to copies of an Italian newspaper an autograph letter from his King to King George and letters to Lloyd George, Lord Derby, Mr. Balfour, Lord Montagu of Beaulieu, and the Lord Mayor of London.

War Industries Board Reorganized

The Council of National Defense has announced the reorganization under the War Industries Board of the Automotive Products Committee, which will have advisory supervision on all matters involving the use of internal combustion engines, including the production of motor cars, trucks and ambulances, tractors, motor-boats and airplane engines. The Committee will serve under the administration of Robert S. Brookings, member of the War Industries Board in charge of finished products.

The membership of the committee, as reorganized, is as follows: Chairman, H. L. Horning, tractors and trucks; C. W. Stiger, representing the Motor and Accessory Association; Colonel Chauncey M. Baker of the Quartermaster's Corps; Coker F. Clarkson, representing the Society of Automotive Engineers; Frank W. Russell, representing the Manufacturers' Aircraft Association; T. W. Henderson, representing the Motor-cycle Association; Henry R. Sutphen, representing the Motor-boat Association and Hugh Frayne, member of the War Industries Board, representing labor.

A special auxiliary committee has been appointed to work on the military truck program in co-operation with the Quartermaster's Corps. Sub-committees will also be appointed on priority, gasoline and military motor-cycles.

Transatlantic Flight Projected

Preparations are being made in England for crossing the Atlantic from east to west by airplane in one day, according to an announcement made by J. A. Whitehead, governing director of the Whitehead Aircraft, Limited, to the London *Daily Sketch.*

"When our plans are full matured," he said, "we shall make a trip which will be the most sensational in the whole history of aviation. The aeroplane will be piloted by Herbert Sykes, who anticipates leaving Hanworth Park, Feltham Middlesex, at dawn and reaching New York before night. The trip will be accomplished on a specially designed very powerful Whitehead machine which is being built at our Middlesex factory. Edgar Middleton will accompany Mr. Sykes as navigator. He has served in an Essex regiment and was sublieutenant. Both are immensely enthusiastic and confident."

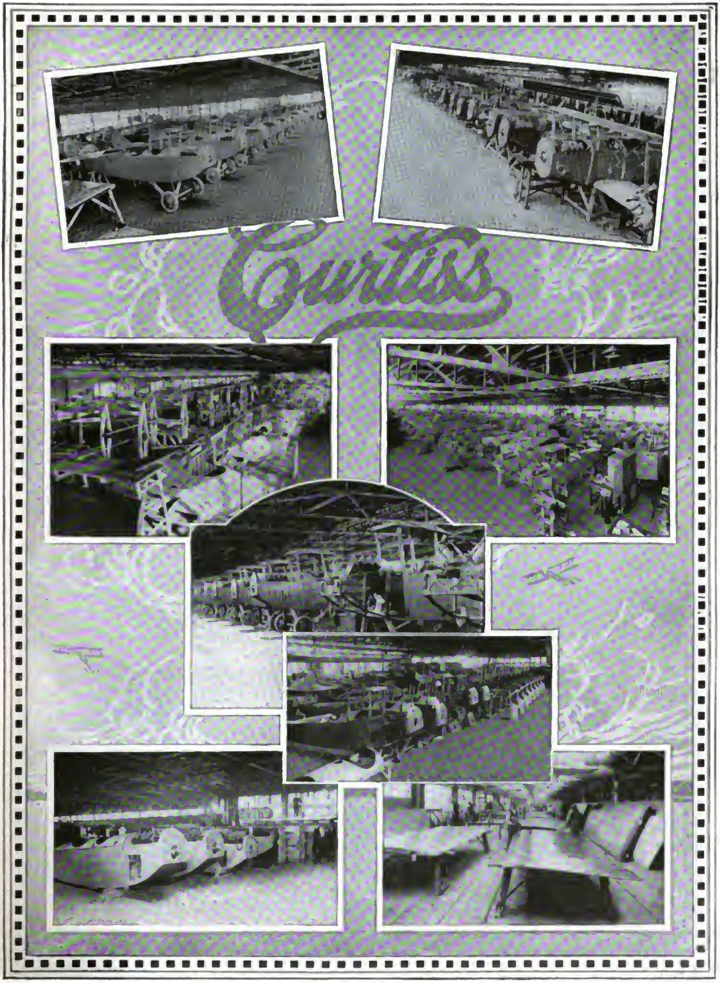
American airmen in England are dubious about the outcome of this scheme. An American officer pointed out to a *Daily News* representative the difficulties in the way at this time of year when equinoctial gales are due.

"The prevailing Atlantic winds," he said, "are from our side to yours, and experiments to be successful need a most favorable condition. A worse period for crossing to America from Europe could not be chosen than that between now and the end of next March. I see it is announced that the flight will occupy about 12 hr., which means 250 miles an hour in the teeth of the wind. Just look at the proposition."

Specifications Issued for Airplane Materials

Preliminary specifications for international standards of airplane materials are being issued by the International Airplane Standardization Board in Washington. This work has been in charge of F. G. Diffin, and copies of the Standards adopted may be obtained by manufacturers interested by application to the International Aircraft Standards Board, Room 224, Bond Building, Washington, D. C.

All international standards on airplane materials and fabricated parts in the future will be issued from the office of the Board, and can be had on application.



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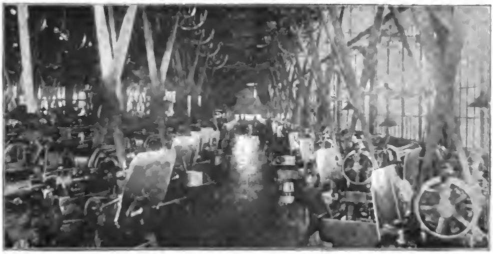

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326 Short, Female
326 Long, Female
327 Long, Male
327 Long, Female
327 Short, Female
328 Long, Female
329 Long, Female

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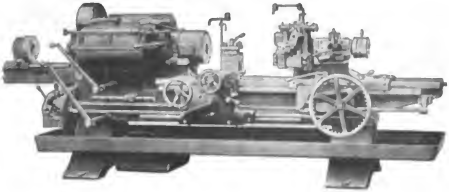

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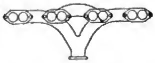

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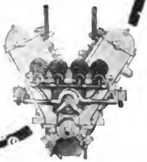

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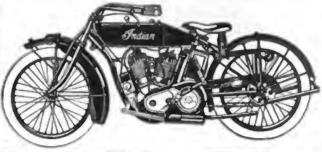

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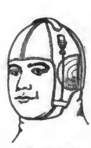

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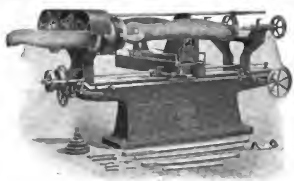

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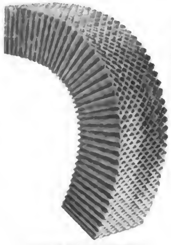

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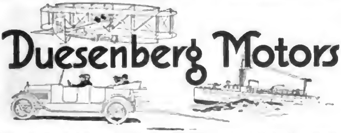

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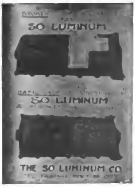

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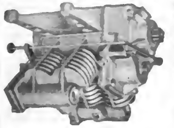

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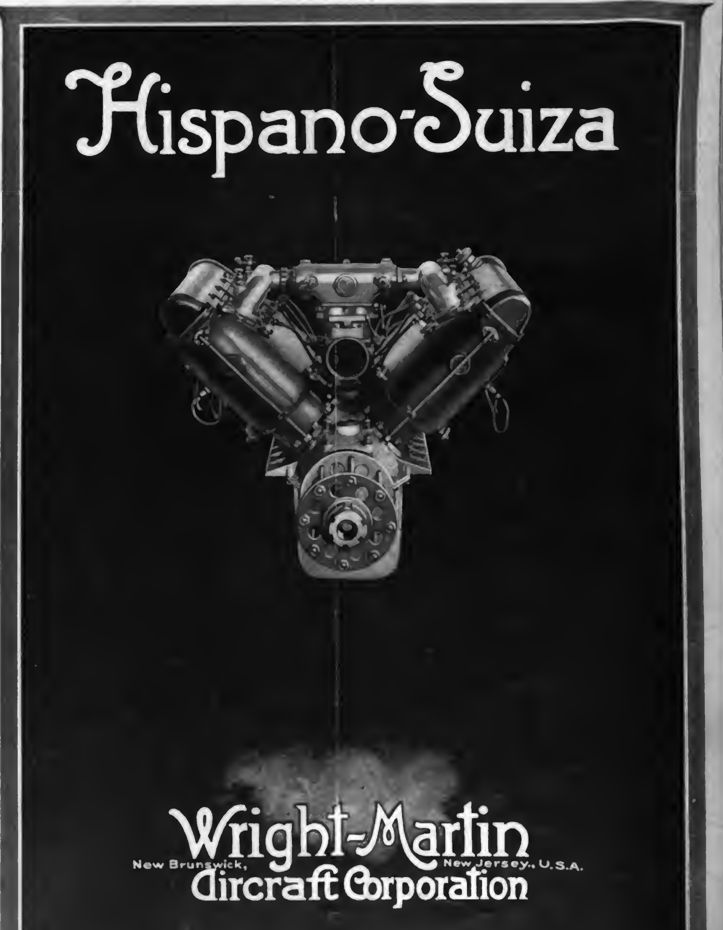
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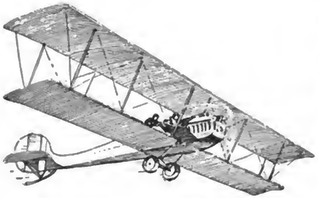

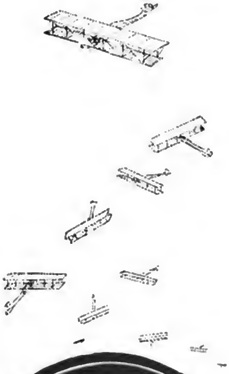

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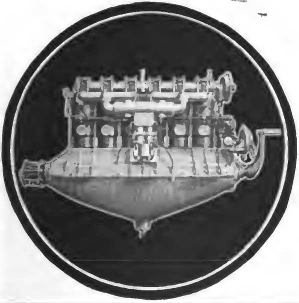

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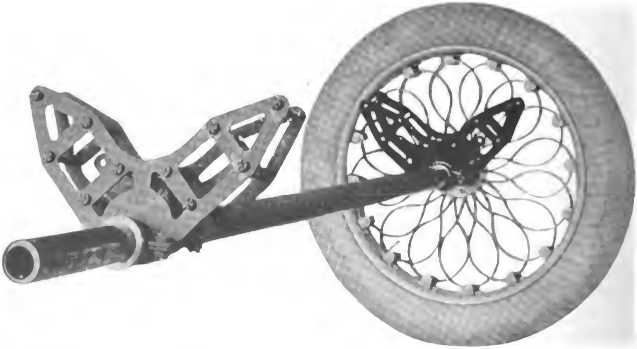

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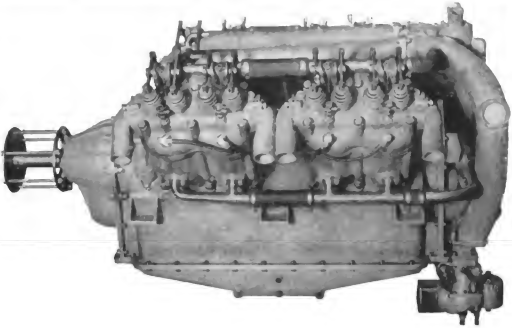

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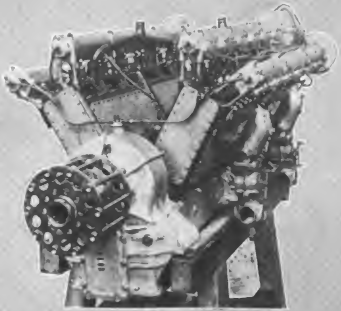

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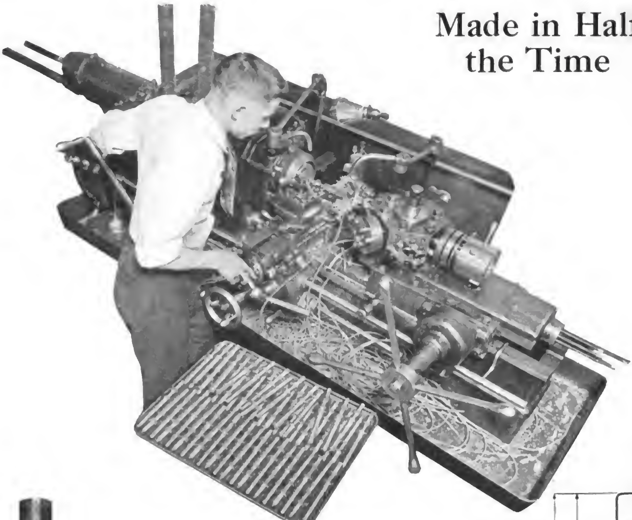

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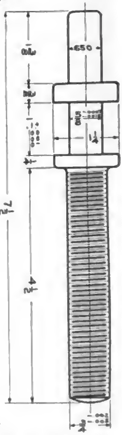

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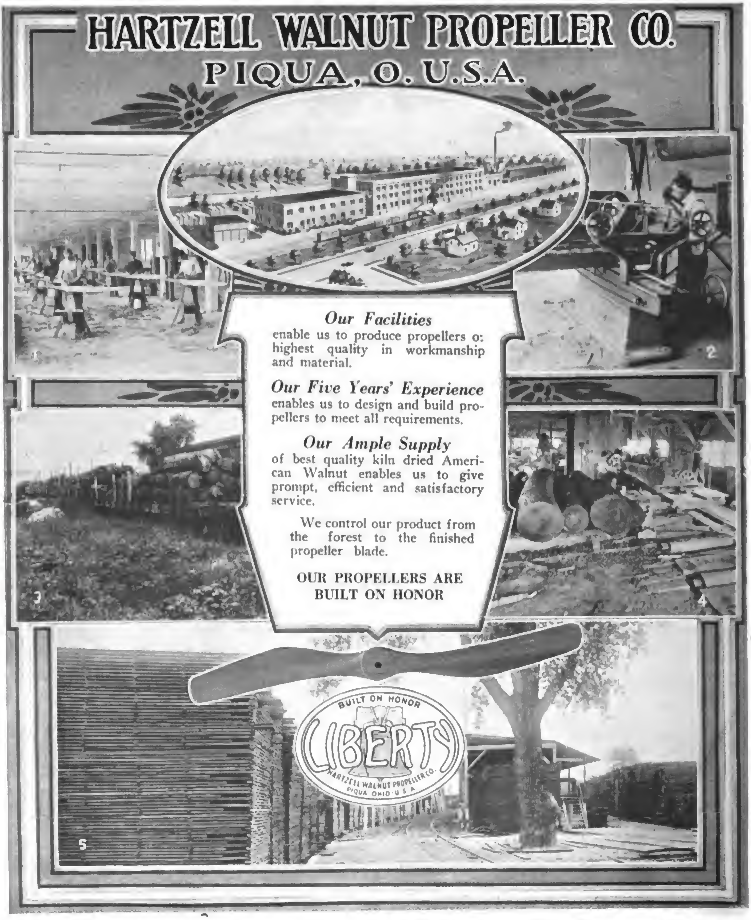

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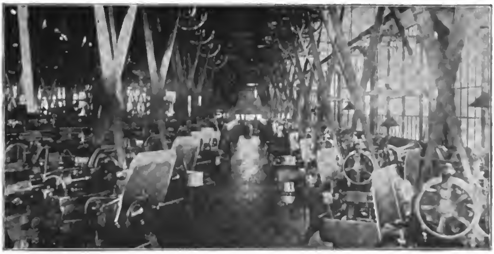

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AVIATION
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VOL. III. NO. 6

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Vol. III **October 15, 1917** **No. 6**

Means of Obtaining High Volumetric Efficiency for Aviation Engines

Although it is at the present time impossible to give any definite rules and regulations in regard to design of valves, intake and exhaust ports of airplane engines, a few general facts may be stated which have been found during the latest developments in this country and abroad.

The one and most important point in the design of aviation engines is the matter of reducing the weight of the engine per developed horsepower, without sacrificing the factor of safety and the reliability of the different parts of the engine.

In general it can be said that the weight of a number of parts of an engine is to a certain degree independent of the horsepower developed by the engine. This refers, for instance, to parts such as water pump and connections, ignition systems, camshafts and camshaft drive, lower part of crank case, or oil sump, etc. If, therefore, the developed power of the engine can be increased without adding more cylinders or changing the dimensions of the cylinders, and simply increasing the strength of such parts which are submitted to the additional strain, such as connecting rods, crankshaft, wristpins, etc., it is obvious that a material gain in horsepower per lb. engine weight can be obtained.

Increased developed horsepower without changing the engine dimension can be obtained in two ways, either by increasing the revolutions per min. of the engine, or by increasing the mean effective pressure in the cylinder, or again, a combination of both.

It was not found advisable from the early days of the aviation engine until the last year, to run the engines over 1400 r.p.m. due to the fact that the slippage of the air propeller would become so great at speeds above 1400 r.p.m. that no increased traction could be obtained. In order to maintain a propeller speed of 1400 r.p.m. and still obtain the increased efficiency of the higher speed engine, the development of the geared down engine was taken up. Several successful types of these engines have been put on the market during the past year, and proved in most cases superior to the straight drive engines running at 1400 r.p.m., in that they are somewhat lighter per horsepower.

As an interesting comparison between two engines of above types can be mentioned one of foreign design, this engine was built first as a straight drive engine running 1400 r.p.m. and developing one horsepower per 2.9 lb. engine weight. The same engine was later built to run 2000 r.p.m. with a geared propeller shaft running 1500 r.p.m,, and with the same cylinder and valve dimensions the weight decreased to 2.4 lb. per horsepower.

This development seems, however, recently to have received somewhat of a setback by reason of the development of an air propeller that would give satisfactory efficiency at as high as 1700 r.p.m. It is generally found in comparing a geared down engine, running at 2100 r.p.m with an engine of same cylinder dimensions and valve construction but running as a straight drive at 1700 r.p.m., that the weight of the gears offsets the increased power output, due to the increased engine revolutions, and that the total horsepower per pound becomes approximately the same in both cases, and the less complicated straight drive engine is usually preferred. A further example of this can be found in the same engine mentioned above. This engine was further developed to run 1700 r.p.m. straight drive, and found to develop one horsepower per 2.2 lb. engine weight.

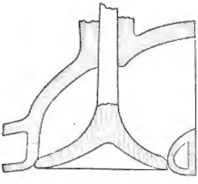


FIG. 1

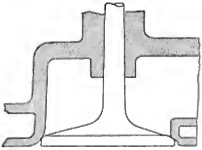


FIG. 2

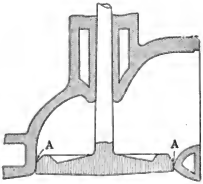


FIG. 3

The only remaining means of increasing the developed horsepower without increasing the cylinder dimensions or the number of cylinders is, therefore, to increase the explosive pressure, or mean effective pressure by increasing the charge of gas into each cylinder. The effect of the compression ratio has not been given any consideration in above, due to the fact that in general present day practice the compression ratio has been brought up to the limit of what can be used in practice. A compression ratio of 16.5 per cent to 17 per cent is all that can be used, and an engine with this compression ratio cannot be run with wide open throttle under full load on the ground for more than 10 to 15 min. at a time without risking unnecessary damage to the crankshaft bearings, due to excessive vibrations. Such an engine is generally tested and used on the ground up to 75 per cent of full load, the remaining power being used only when the airplane in which the engine is mounted has reached an altitude where the lower air pressure reduces the compression so much that the engine will run normally at full open throttle.

It can be seen from the above that no additional power output can be obtained by varying the compression ratio once the maximum practical compression ratio has been reached, and that designers of aviation engines have only the increase in mean effective pressure left as a means of obtaining higher output per pound weight.

The ways of increasing the charge of fuel in the cylinders for each explosion can be divided into two classes, the normal intake where the downward stroke of the piston creates the vacuum necessary to fill the cylinder with gas, and the forced intake, where by some means the charge is forced in under pressure.

In considering the first class of normal intake the force that draws the mixture into the cylinder is determined once the piston speed and dimensions are determined, and the charge can only be increased by decreasing the resistance which the incoming charge meets on its way from the carburetor to the cylinder head.

The piston will under normal conditions never draw as much charge per suction stroke as is represented by the piston displacement volume at atmospheric pressure, and temperature. The ratio of charge drawn in varies with the engine speed and temperature and will in a hot engine decrease at first rapidly with increasing speeds, then less rapidly, and becomes constant or increases at speeds of 1300 to 1400 r.p.m. The ratio of the charge drawn in compared with the volume displaced by the piston will vary from 70 to 80 per cent.

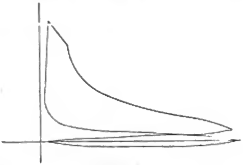


FIG. 4

The first question that rises here is the question of number of valves per cylinder, whether two, three or four valves are preferable. The construction that will give the most open area for the intake valve is the most desirable, and will produce the most power, and this is generally obtained by using two intake valves per cylinder. It depends, however, upon the shape of the cylinder head and the location of the valves and must be decided in each case.

The lower weight of the smaller valves will allow a quicker and more sudden opening and closing of the valve, due to less reciprocating weight and thus allow the duration of the opening of the valves to be increased to the limit. As a matter of strength the smaller valves offer better advantage due to the lower weight and weaker springs. The disadvantage of the two valves per cylinder lies in the complication in the system of rocker-arms and camshaft, which can, however, be somewhat offset by using forked rocker-arms so that both valves are operated by the same cam and the same rockers.

The question of exhaust valves is somewhat different. The main point here is not to avoid resistance in the expulsion of the burnt gases, as these are not driven by a vacuum, but by a positive pressure force, the point of most importance is here to provide sufficient cooling of the lower part of the valve.

The valve is cooled at two points around the seat when the valve is closed and around the stem where this is in contact with the valve guide. Inasmuch as the larger part of the heat is carried out through the stem and the valve guide, provided the guide is properly cooled, it can easily be understood that the valve will run cooler when the mushroom part from which the stem draws the heat is small. This favors also the use of two smaller exhaust valves per cylinder.

Another factor that must be considered in the design of the exhaust valves is the warpage under heat. While it is advisable from the point of view of cooling to use a wide seat that will offer a large surface of contact while the valve is closed, such a wide seat is liable to become untight and cause loss of compression. As a general rule it can be said that where the construction of camshaft and cylinder head will allow it, it will be found advantageous to use four valves per cylinder.

The general design of the valves has been left unchanged for several years, and it is just recently that the increased competition among aviation engine builders has brought out development work along this line. Heretofore, it was and is yet in many cases common practice to have the design of the intake and the exhaust valves alike, so that the valves are interchangeable.

Lately the tendency has, however, been to design the intake valves with more direct regard to the free flow of incoming charge. The most disturbing effect in the distribution of the gas from the carburetor to the cylinder, is the creation of eddies in the incoming mixture. These offer an appreciable retardation against the free flow of gas. Intake valves and intake ports in the cylinder heads should, therefore, be designed in such a way as to offer the least possible tendency to create eddies. This can be obtained by giving the passage between the valve and the walls of the ports as much of a stream-line shape as possible, and avoid all sharp projecting points or hollow corners in the ports.

Intake valves with a cone shaped power port, or with a heavy fillet, as shown in Fig. 1, have recently been brought out by some domestic and foreign engine builders, and have given very good results.

Fig. 2 shows an intake port and valve of older design, and it can readily be seen that this construction will offer an increased resistance in the gas passage and cause eddies.

The exhaust valves have also undergone several changes lately, and as it is important here to minimize the heating of the lower part of the valve the design as shown in Fig. 3 has been brought out. The rim of the valve is raised above the inner surface of the mushroom partly to prevent the hot gasses from coming into contact with the surface marked *A A*, and thus heating the lower part of the port of the valve, and partly to reinforce and provide more body to the rim of the valve which is most exposed to the heat and most liable to warp.

Another point which has no bearing on the power output of the engine, but which is of vital importance in reliability and endurance, is the proper cooling and water jacketing of the exhaust valve seat and exhaust valve stem. Improper cooling has given more valve trouble in the past than any other cause, and the importance of water cooled valve guides cannot be overemphasized. The valve guide should have a waterjacket all around it and the design of the jacket must provide a continuous flow of water in the jacket, not merely form a waterpocket where little or no circulation of water takes place.

However, no matter how carefully the intake passages and valve designs are made there is always a limit to the charge that can be drawn into the cylinders through normal suction, and in order to further raise the horsepower output of the engine the designer must look toward intake or supercharge as the technical term has been designated.

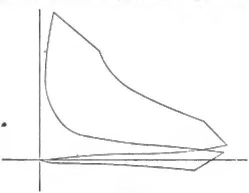


FIG. 5

It has been attempted to supercharge the cylinders in different ways. So far only one has proven successful, that is to take in a charge of overrich mixture through normal piston suction and then admit pure air at the bottom of the intake stroke under pressure.

To inject the correct mixture under pressure has not proven successful, owing to the fact that the gasoline vapors will condense under pressure and uniform mixture cannot be obtained in this way. The actual working of the supercharged engine can be explained as follows: As mentioned above there is a limit over which it is impossible to raise the compression without exposing parts of the engine to undue strain. The supercharged engine is submitted to the same condition and the compression measured in pounds per square inch must remain the same. The advantage is, however, obtained in the possibility of using a larger explosion chamber for the same piston area, and thus firing a larger charge of gas, compressed to the same pressure as for a normal engine.

The effect of this can roughly be seen on the sketch of the diagram in Fig. 4 and Fig. 5. Fig. 4 shows the diagram of the explosion stroke of a normal engine. This shows the rapid decrease in pressure after the explosion has occurred.

In a supercharged engine where a larger body of charge is burned under the same compression, the initial pressure will be somewhat higher, but the most important point is that the pressure will decrease much more slowly, due to the larger ratio between the combustion chamber and the increase in volume caused by the downward travel of the piston. In other words, most of the additional power is obtained after the combustion has taken place, rather than in the moment of the combustion.

The advantage of this is evident, for the pistons, wristpins, connecting rods, crankshaft, etc., are not subjected to a materially higher initial strain, but rather to a steady force following after the combustion. In other words, only a slight increase in the dimensions of the above parts is necessary, and the performance of the engine approaches that of a steam engine in its freedom from vibrations. In engines of this type as much as 100 per cent or more increase in horsepower over engines of the same dimensions, but with normal intake, has been obtained.

It is furthermore possible with supercharged engines to vary the compression with very simple mechanical arrangements, by varying the pressure of the compressed air admitted to the cylinder at the bottom of the intake stroke, so that the correct compression can be maintained at all altitudes to which the airplane may ascend. The present development seems to indicate strongly that the future of the aviation engine belongs to the supercharged type engine.

Determination of the Moments of Inertia of an Airplane

By John J. Rooney

The sum of the products of the mass of each elementary part of a body and the square of its distance from a given axis is called the moment of inertia of the body about that axis. In the case of the solid, there are always three rectangular axes passing through any particular point, about each of which it is necessary to know the moment of inertia.

When the point selected is the center of gravity of the body, the axes are known as the gravity axes. It is the moment of inertia of the airplane about each gravity axis that is required in stability computations.

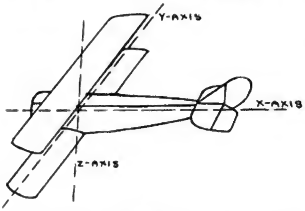


Fig. 1

The gravity axes of an airplane are usually selected for the position of horizontal flight, that is, the longitudinal axis is in the plane of symmetry and parallel to the propeller shaft. For convenience in computations, the axes are designated as follows:

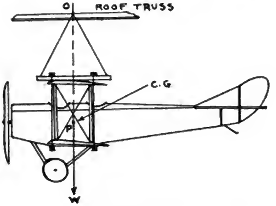


Fig. 2

x-axis—The longitudinal gravity axis in the plane of symmetry.

y-axis—The transverse gravity axis.

z-axis—The vertical gravity axis.

In this article it is proposed to explain how the center of gravity and moments of inertia of a complete airplane can be determined experimentally.

Method of Finding the Center of Gravity

As the center of gravity of a well designed airplane is in its plane of symmetry, it is only necessary to determine the x and z coordinates from fixed reference points in the plane to know its position.

(a) *x-Coordinate.*—This coordinate which is measured along the x-axis from the reference point to the center of gravity, is determined by weighing the airplane on two platform scales placed under its nose and tail, observing the separate weights, measuring the distance between the points of support, and then taking moments about one of the points.

(b) *z-Coordinate.*—As the methods of determining the moments of inertia to be described requires the airplane to be suspended from a pivot so that it is free to oscillate as a compound pendulum, the z-coordinate is determined by a method which makes use of the same suspension.

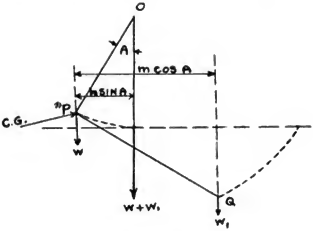


Fig. 3

The airplane is first suspended with the x-axis horizontal from a point in the z-axis some distance above the top wing, as shown in Fig 2, then deflected through an angle by means of a known weight attached to the tail at a known distance from the z-axis, as shown diagramatically in Fig. 3.

Then if W = weight of airplane;

W_1 = weight added on tail;

$OP = h$, unknown distance measured along z-axis from point of suspension to center of gravity;

$PQ = m$, known distance measured along x-axis from z-axis to point of attachment of W_1;

A = angle through which airplane is deflected.

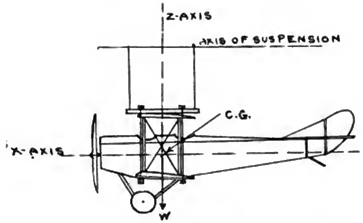
By taking moments about P, we have

$$h = m\ W_1 \cot A / (W_1 + W) \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

In using this method it is advisable to make A as large as possible and thereby minimize errors. In measuring the angle a plumb bob with a fine cord about 36 in. long should be attached to the body and a mark made at as large a radius as possible for each position of the airplane. As it may be necessary to know the angle in minutes, it should be determined from its tangent and not measured with a protractor.

Methods of Finding Moments of Inertia About Gravity Axes

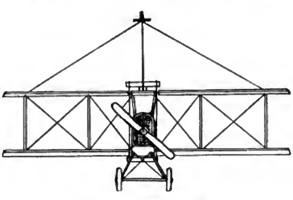
(a) *About x-axis.*—The airplane is suspended in a suitable frame by means of two cables in its plane of symmetry placed equal distances on each side of the center of gravity, as shown in side view of Fig. 4.



SIDE VIEW, FIG. 4

It is essential in making this determination that the airplane oscillate as a rigid body about its axis of suspension and that all secondary vibrations about other axes be eliminated. This condition may be brought about by running small wires from the points of suspension to the wing tips, as shown in front view, Fig. 4. The airplane by a slight touch on the wing tip will now oscillate as prescribed.

Then if I = moment of inertia in (lb. ft.^{2}) of airplane about its x-axis;
k = radius of gyration in ft.
g = acceleration of gravity 32.2 ft. per sec.
h = distance in feet from the axis of suspension of the airplane to its center of gravity;
n = number of complete vibrations per min.;
W = weight of airplane in pounds;



FRONT VIEW, FIG. 4

$$K = \sqrt{\frac{gh\ (60)^2}{4\pi^2\ n^2}} - h^2 \text{............ft.} \quad (2)$$

$$\therefore I = K^2\ W \text{...........................(lb. ft.}^2\text{)} \quad (3)$$

No vibrations should be measured while the amplitude is large, and a stop watch should be used for timing.

(b) *About y-axis.*—The airplane is suspended as shown in Fig. 2, so as to be free to oscillate in its plane of symmetry. Since the airplane is now suspended from a point, some such fitting as shown in Fig. 5 should be used when the cables are drawn together, in order to eliminate precession.

The airplane is now free to oscillate about an axis parallel to its y-axis. The observations required are the same as those already given. The moment of inertia about the y-axis is computed from the formulae (2) and (3).

(c) *About z-axis.*—The same suspension shown in Fig. 4, with the exception of the auxiliary wires, is used for this determination. This suspension, as may be observed, permits the airplane to oscillate freely about its z-axis after it is once set in motion.

Then if r = distance in ft. from z-axis to supporting cables;
l = length of cables in ft. from axis of suspension to points of attachment.

$$K = \frac{30r}{\pi n}\sqrt{g/l} \text{..................................ft.} \quad (4)$$

$$\therefore I = K^2 W \text{..................................lb. ft.}^2 \quad (5)$$

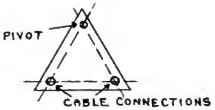


FIG. 5

Results of an Experiment.—The following tabulated results were obtained by the methods outlined for an American made, two-place reconnaissance airplane, of 50 ft. span and weighing, fully loaded, for six hours' flight, 2900 lb.:

(a)	*About x-axis:*	
	I_x	75,250 lb. ft.^{2}
	K_x	5.10 ft.
(b)	*About y-axis:*	
	I_y	63,600 lb. ft.^{2}
	K_y	4.70 ft.
(c)	*About z-axis:*	
	I_z	151,000 lb. ft.^{2}
	K_z	7.24 ft.

Formulae for Approximate Calculation of Brake Horse Power of Airplane Engines

By Archibald Black

Several formulae are in use at present for the approximate calculation of brake horsepower of gasoline engines but, with the exception of the old "plan" formula of the steam engineers, none of them would appear to be of any value when applied to airplane engines. Then, of course, with the "plan" formula it is necessary to assume a mean effective pressure, which is not the actual mean effective pressure, anyhow, as the figure used must be modified to give the result in brake horsepower.

The formulae of the American Power Boat Association take into consideration most of the factors directly and cover the others by means of constants dependent upon the type of engine, two or four cycle. These formulae, which, it will be noted, are based on the "plan" formula, are:

B = bore in inches; S = stroke in inches; N = number of cylinders; R = number of r.p.m.

$$\text{B.h.p. (two cycle)} = \frac{B^2\,S\,N\,R}{12{,}000} \qquad \text{B.h.p. (four cycle)} = \frac{B^2\,S\,N\,R}{16{,}000}$$

In the form given these are of no value in estimating horse power of airplane engines, but it would appear that modifications could be made in the constants, which would convert these formulae into a form in which they could be applied with approximate accuracy to this type of engine.

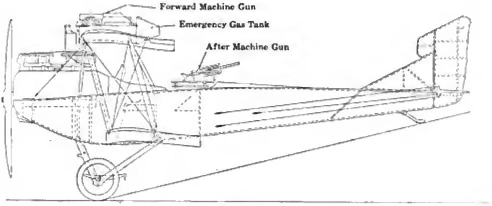
With this object in view constants were calculated from the performances of nine of the leading American engines and the results averaged. None of the data on these engines is given on account of possible objections to publication at this time. These results give an average constant of 10,395 and show variations within limits of 15 per cent above and 7½ per cent below this average.

It would therefore appear that the brake horse power of airplane engines is given with approximate accuracy by the formula: $\frac{B^2\,S\,N\,R}{10{,}400}$

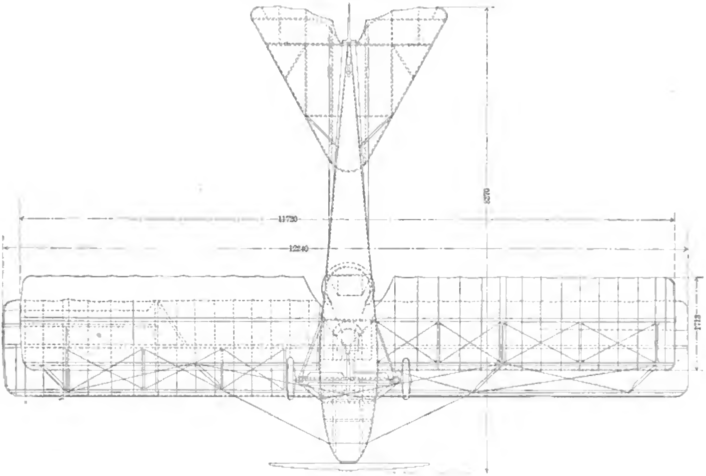
Detail Drawings of an Austrian Albatros Biplane

Hansa-Brandenburg Type, 200 HP. Warchalowski Engine

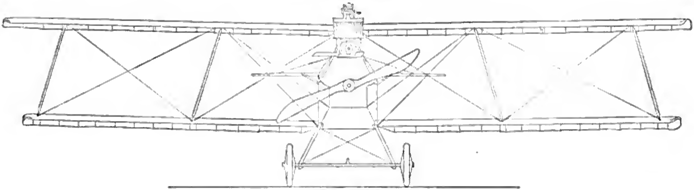
(Dimensions in Millimeters)



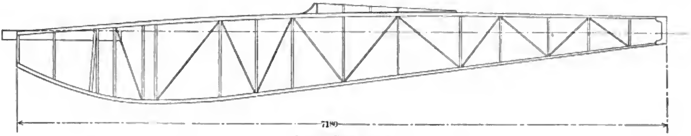
Side View



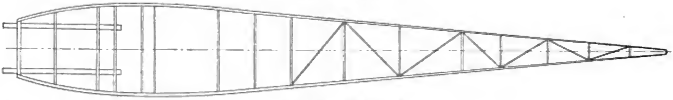
Bottom View



Front View



Body, Side View



Body, Bottom View

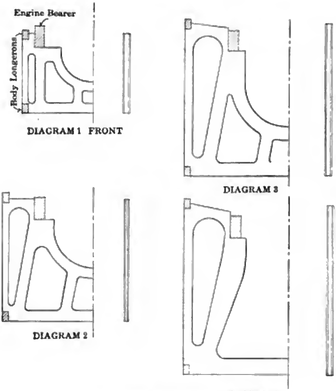


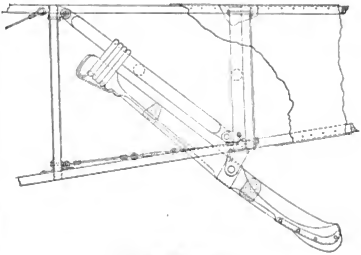
DIAGRAM 1 FRONT

DIAGRAM 3

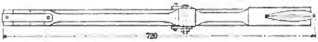
DIAGRAM 2

DIAGRAM 4

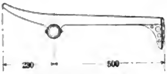
Engine Mounting



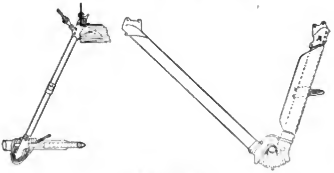
Tail Skid Mounting



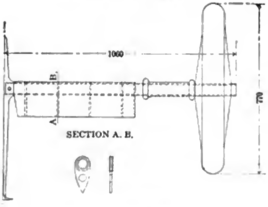
Tail Skid, Bottom View



Landing Brake

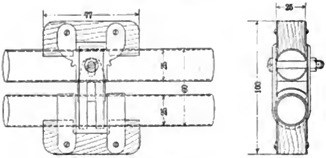


Chassis Struts

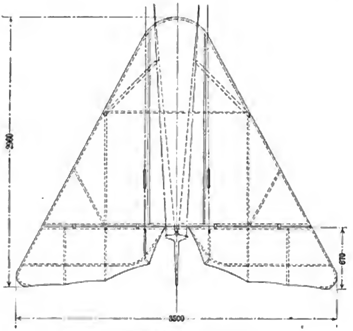


SECTION A. B.

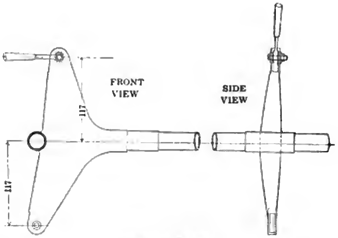
Running Gear



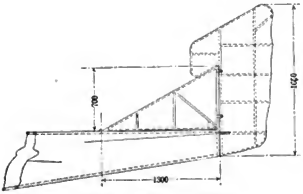
Tail Hinge



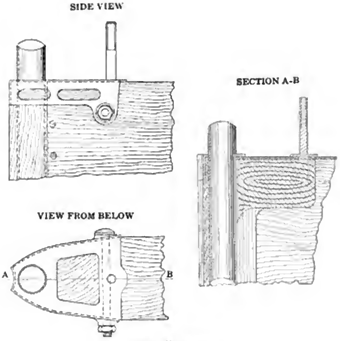
Stabilizer and Elevator



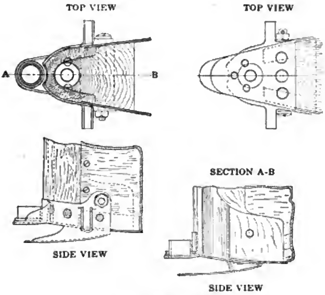
Control Lever



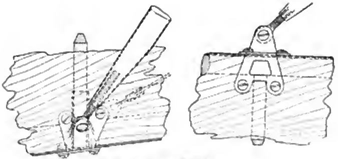
Vertical Fin and Rudder



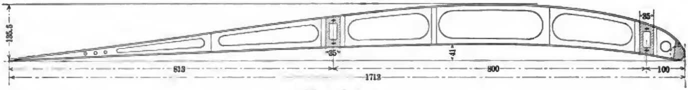
Tail Fitting



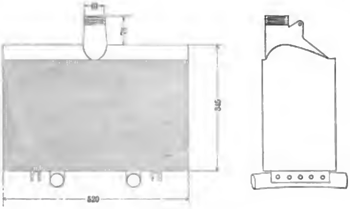
Tail Post and Skid



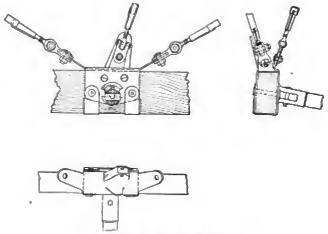
Stabilizer Fitting



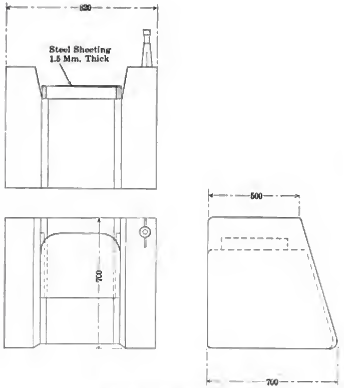
WING SECTION



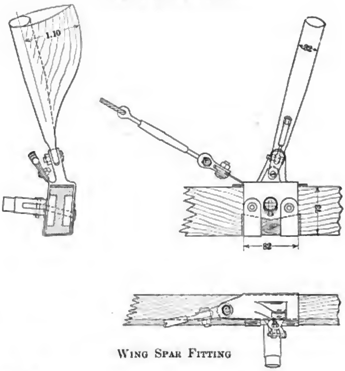
RADIATOR



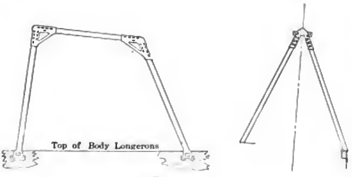
LOWER WING SPAR FITTING



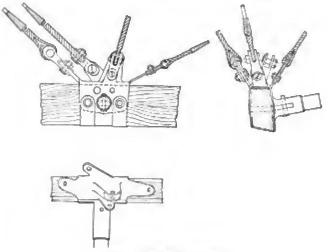
MAIN TANK, WITH SEAT



WING SPAR FITTING



CABANE



WING SPAR FITTING

International Aircraft Standards

The International Aircraft Standards Board, which since the end of July has been holding meetings at the Bureau of Standards, Washington, D. C., for the purpose of standardizing aircraft material specification for purchases of the Allied Governments in this country, has commenced to issue the "International Aircraft Standards" that have been adopted. This Board, of which Frank G. Diffin is chairman and Dr. P. D. Merica is secretary, is also composed of representatives of the aircraft departments of Great Britain (Canada), France and Italy, and of the Signal Corps of the Army and the Bureau of Construction of the Navy of the United States.

It has endeavored to standardize the materials entering into aircraft construction in such a manner as to conform with American manufacturing practice as far as possible and at the same time to be of the greatest service to our Allies making purchases in this country. It will be noted that both the English and metric systems are used throughout these specifications.

The specifications that are now available follow:

Classification of International Aircraft Standards—Serial Numbers of I. A. S. B. Specifications

The specifications receive serial numbers according to the following classification:

Series 1. Covers general inspection and testing instructions.
Series 2. Covers raw materials, wood, ingot metals, etc.
Series 3. Covers fabricated material, such as bars, castings, etc.
Series 4. Covers fabricated parts, such as turnbuckles, ferrules, fittings, etc.

Series 2 and 3 will be further subdivided according to the type of material:

2F. Fabrics and dope.
2N. Nonferrous metals.
2O. Oil and gasoline.
2S. Steel and iron.
2V. Varnish and glue.
2W. Wood.

Series 4 is subdivided as follows:

4A. Accessories.
4E. Engine.
4I. Instruments.
4P. Plane, frame, etc.

1L1—List of Specifications

1L1. List of specifications.
1G1. General specifications for the testing and inspection of metallic materials.
1A1. Methods of chemical analysis.
2S1. Chemical compositions of steels.
2N1. Ingot aluminum.
2N2. Ingot copper.
2N3. Spelter.
3S1. Carbon steel for case-hardening.
3S2. Medium carbon steel bars and billets.
3S3. Alloy steel bars and billets, 100,000 lbs. per sq. in. tensile strength.
3S4. Alloy steel bars and billets, 125,000 lbs. per sq. in. tensile strength.
3S5. Alloy steel bars and billets, 150,000 lbs. per sq. in. tensile strength.
3S6. Alloy steel bars and billets, 175,000 lbs. per sq. in. tensile strength.
3S7. Alloy steel bars and billets, 200,000 lbs. per sq. in. tensile strength.
3S8. Alloy steel bars and billets, 225,000 lbs. per sq. in. tensile strength.
3S9. Alloy steel bars and billets for case-hardening, 170,000 lbs. per sq. in. tensile strength.
3S10. Alloy steel bars and billets for case-hardening, 190,000 lbs. per sq. in. tensile strength.
3S11. Tolerance on steel bars.
3S12. High-strength steel wire.
3S13. 19 non-flexible steel-wire cable.
3S14. 7 by 7 non-flexible steel-wire cable.
3S15. 7 by 19 extra-flexible steel-wire cable.
3S16. Wire for acetylene welding.
3S17. Wire for electric welding.
3N1. Gun-metal castings.
3N2. Manganese bronze castings.
3N3. Phosphor bronze castings.
3N4. Naval brass or equivalent alloy bars.
3N5. Naval brass or equivalent alloy sheet.
3N6. Sheet brass.
3N7. Brass tubes.
3N8. Sheet copper.
3N9. Phosphor bronze strip.
3N10. Babbitt metal.
3N11. Aluminum alloy castings.
3N12. Sheet aluminum.
4P1. Turnbuckles.
4P2. Ferrules and thimbles.

1G1—General Specifications for the Testing and Inspection of Metallic Materials

General.—1. These specifications will form part of all individual specifications for metallic materials.

Material.—2. (*a*) An analysis of each lot of material and of each heat of steel fůrnished to this specification shall be made by the manufacturer. The chemical composition thus determined shall be reported to the purchaser and the Government inspector, and shall conform to the requirements of the specification.

(*b*) In the case of submission of lots of material of which the heat or identification marks are lacking or doubtful the manufacturer will be required to furnish analyses of a sufficient number of the articles submitted to satisfy the inspector of the uniformity of the lot.

(*c*) An analysis may be made by the purchaser or Government inspector from a tube, sheet, bar, or test bar or casting representing each lot of material submitted, and the chemical analysis thus determined shall conform to the requirements specified. If the analysis of any one article does not conform to the requirements specified, analyses of two additional articles of the same lot shall be made, unless otherwise noted, each of which shall conform to the requirements specified.

(*d*) The methods for chemical analysis shall be those of the I. A. S. B.

(*e*) The weight of sample taken for analysis shall be not less than 120g., and the sample shall be clean, free from rust, oxide, and extraneous matter, and is to be taken with a slow-speed tool.

(*f*) Drillings for analysis of bars, billets, or other regular shapes shall be taken parallel to the axis at any point midway between the center and surface.

(*g*) Drillings for analysis may be taken from broken tension or bend test specimens when physical requirements are specified.

(*h*) Wire, tubing, sheets, and rods less than 1¼ in. (31.75 mm.) in thickness, shall be sampled through or across the entire section.

(*i*) In case of suspected segregation (steel), a sample may be taken from a point on the axis and analyzed; the percentage of no element may exceed at this point by more than 15 per cent that specified.

(*j*) In order to obtain evidence of possible unsoundness and piping, sample bars of steel may be nicked and broken for examination of fracture.

(*k*) Drillings or cuttings for the analysis of irregularly shaped pieces (steel), for which no physical requirements are specified, shall be taken from both the thickest and the thinnest sections. Surface drillings shall be discarded.

Manufacture.—3. (*a*) The materials shall be manufactured according to the best current practice.

(*b*) Steel shall be manufactured or at least finished by the open-hearth, electric-furnace, or crucible process unless otherwise noted.

(*c*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*d*) The billets from which bars or forgings are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar or forging. No undercutting in chipping will be allowed.

Heat Treatment.—(*e*) The manufacturer shall state the heat treatment recommended to give the physical properties specified for all steels which are to be used in the heat-treated condition.

Workmanship and Finish—4. (*a*) The articles must be finished in a workmanlike manner and must be free from flaws, surface and other defects to which they are subject.

(*b*) Any article may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously passed the physical and chemical tests; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—(*a*) Physical tests shall be carried out on testing machines of standard make, which are to be kept in good working condition. The manufacturer must satisfy the inspector that the testing machines are at all times properly calibrated.

Tensile Test.—(*b*) To determine whether a specimen has a yield point equal to or greater than that specified the procedure shall be as follows: A line shall be scribed on the test piece with a punch mark as center, and with a radius of about 2 in. (50.8 mm.) when possible; the specified load shall then be applied, removed, and a second line scribed with the same radius and the same center; if two lines are then seen on the test piece, indicating that permanent elongation has occurred, it shall be considered that the specimen has not passed the yield-point test. If the manufacturer desires, the yield point may be determined by an approved autographic or extensometer method.

(*c*) The elastic or the proportional limit, when called for, shall be determined with an extensometer reading to at least 0.002 in. (0.05 mm.). It shall be attached to the specimen at the gage marks and not to the shoulders of the specimen nor to any part of the testing machine. The elastic limit is defined as the greatest load per unit of original cross section which does not produce a permanent set. The proportional limit is the load per unit of original cross-section at which the deformation ceases to be proportional to the load.

Bend Test.—(*d*) The specimens shall be bent cold in the bend test.

(*e*) (*Bars*). Bars will be bent around a pin of radius equal to the bar diameter or thickness until the sides are parallel; unless otherwise noted the bar must withstand such bending without developing cracks or signs of failure.

(*f*) (*Sheets*). The test comprises two distinct operations, both of which are performed by the use of a press, or, in the absence of this, by using a knife-edge and hammer. First, the strip is placed in position *AB* (Fig. 2*a*) on block having a V-shaped groove. The knife-edge is placed as shown and pressure is applied by means of either press or hammer until the test specimen assumes the shape *A'MB'*. After this block is removed the bending is finished as indicated in Fig. 2*b*, with or without the interposition of a spacer. The spread of the ends of the test piece varies with the quality and thickness of the sheets. The specimens must be bent as indicated without breaking and after test shall not show hair lines, cracks, or other defects.

Impact Test.—(*g*) Impact tests shall be carried out with an impact testing machine of the pendulum type.

Brinell Hardness Test.—(*h*) The hardness test shall be made with a 10-millimeter diameter ball, using a pressure of 3,000 kgs. for steel and one of 500 kgs. for softer metals. This pressure shall be applied for 30 seconds.

Test Specimens.—(*i*) Tension, bend, and impact test specimens shall be taken from the rolled or forged material, except that in the case of irregularly shaped forgings they may be taken from a full-sized prolongation. Specimens shall not be annealed or otherwise treated, except as provided in the individual specifications.

(*j*) Tension, bend, and impact test specimens for rolled material which is to be annealed or otherwise treated before use shall be cut from properly annealed or similarly treated short lengths of the full section of the piece and for forged material from the treated forgings.

(*k*) The axis of tension, bend, and impact test specimens for rolled bars and forgings of uniform cross-section over 1½ in. (38.10 mm.) in thickness or diameter and for forgings of irregular section, when practicable, shall be located at a point midway between the center and surface when solid and at any point between the inner and outer surfaces of the wall when bored and shall be parallel to the axis of the piece in the direction in which the metal is drawn.

(*l*) Tension test for specimens for bars shall conform to the dimensions shown in Fig. 1. The ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial; test specimens representing heat-treated or brittle materials shall have threaded ends or ends so made as to permit of testing material, using a ball-and-socket chuck.

(*m*) Tension and bend test specimens for plates, sheets, and shapes shall be of the full thickness of material as rolled. Tensile-test specimens for sheets or plates shall be machined to the form and dimensions shown in Fig. 4. Bend-test specimens for sheets shall have a width of 1.5 in. (38.10 mm.) and a minimum length of 8 in. (203.2 mm.). Test specimens shall not be hammered in order to straighten them, nor may they be tempered, annealed, or otherwise treated unless specifically noted. Impact-test specimens are to be rectangular in section and shall be notched on one side. They are to have the form shown in the sketch, Fig. 3.

Selection of Test Specimens—6. A sufficient number of test specimens will be selected by the inspector from each lot of material submitted to satisfy him of the quality of the material. If any test specimen shows defective machining or develops flaws, it may be discarded; in which case the manufacturer and the purchaser or his representative shall agree upon the selection of another specimen in its stead.

Marking and Identification—7. (*a*) It shall be the duty of the manufacturer to provide that manufacturing identification marks, such as heat numbers, shall be readily available at the time of inspection of the finished material to the inspector, and further that materials shall be grouped when possible by heat or melt numbers.

(*b*) It shall be the duty of the manufacturer to stamp individual large articles such as billets, forgings, or castings, with the heat or other identification number; smaller articles may similarly be bundled or grouped under the proper identification number or mark.

Inspection and Rejection—8. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturers' works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment.

(*b*) The purchaser may make the tests to govern the acceptance or rejection of the material in his own laboratory or elsewhere as a check upon the results obtained by the manufacturer, or in case the latter has not the necessary equipment. Such tests, however, shall be made at the expense of the purchaser.

Rejection.—(*d*) Unless otherwise specified, any rejection based on tests made in accordance with paragraph 8*b*, shall be reported within ten working days from the receipt of samples.

Rehearing.—(*e*) Samples tested in accordance with paragraph 8*b*, which represents rejected material, shall be preserved for one month from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

(*f*) All material rejected by the inspector shall bear the letters R A.

Salvage.—9. (*a*) The manufacturer shall hold at his factory, subject to the decision of the salvage board, for a period of not exceeding twenty days from date of the test report, all rejected material.

(*b*) Material held up and accepted by the salvage board shall be marked and shipped as directed by said board, and in presence of the Government inspector, who shall seal the same with his official seal.

(*c*) The manufacturer shall suffer no reduction in price in consequence of the submission of material to or acceptance of said material by the salvage board. It is clearly understood, however, that inspection and acceptance at the factory by a representative of the purchasing Government, or salvage board, will not relieve the manufacturer from the responsibility of furnishing material of known properties and good workmanship, and if it is found on arrival at destination that such is not the case, the material shall be returned at the expense of the manufacturer and replaced with other material conforming to the specifications in every respect. Such replacement shall not be subject to the action of the salvage board. The recurrence of such a case shall constitute cause for cancellation of unfilled orders and for a recommendation against placing further business with said manufacturer.

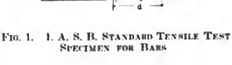


Fig. 1. I. A. S. B. Standard Tensile Test Specimen for Bars

	Dimensions.				
Diameter of Bars	Cross section over gage length.	a	b Diameter over gage length.	c Gage length	d
	Square inch	*Inch.*	*Inch.*	*Inches.*	*Inches.*
Over five-eighths inch	0.20	Not over 1	0.505	2.00	2.25
One-half to five-eighths inch	.10	Not over 1	.358	1.42	1.75
Three-eighths to one-half inch	.05	Not over 1	.252	1.01	1.25
One-fourth to three-eighths inch	.02	Not over 1	.159	.64	1.00
	Square millimeters.	*Millimeters.*	*Millimeters.*	*Millimeters.*	*Millimeters.*
Over 15.88 millimeters	129.0	Not over 25.4	12.83	50.80	57.15
12.70 to 15.88 millimeters	64.5	Not over 25.4	9.09	36.07	44.45
9.53 to 12.70 millimeters	32.3	Not over 25.4	6.40	25.65	31.75
6.35 to 9.53 millimeters	12.9	Not over 25.4	4.04	16.26	25.40

Test specimens may be tapered inside gage length (*c*) toward the center to an amount not to exceed 0.003 in. (0.08 mm.). Diameter at center (*b*) to conform to dimension called for. This will cause fracture near the center of the gage length.

The test specimen will be either threaded (end *A*) or left unthreaded (end *B*), according to method of chucking used.

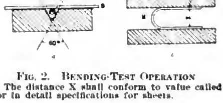


Fig. 2. Bending-Test Operation

The distance X shall conform to value called for in detail specifications for sheets.

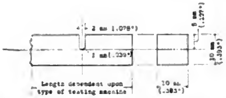


FIG. 3. I. A. S. B. STANDARD IMPACT TEST SPECIMEN

The faces are to be true and parallel.

The base of the notch is to be of uniform depth and perpendicular to the long axis of the specimen.

For unheat-treated material the notch is to be drilled and slotted. For heat-treated material the notch may be ground or milled.

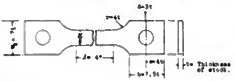


FIG. 4. I. A. S. B. STANDARD TENSILE TEST SPECIMEN FOR SHEETS

Test specimens in accordance with the above sketch shall apply to sheet one-fifth inch (5.08 mm.) (No. 6 U. S. standard gage) and up in thickness. Below one-fifth inch (5.08 mm.) in thickness *w* and *d* shall be one-half inch (12.70 mm.), *h* ½ inch (12.70 mm.), and *w* 1 in. (25.40 mm.). The percentage of elongation may be determined on either 2 or 4 in. (50.80 mm. or 101.60 mm.)

Soft materials of light gage are apt to fail in detail under the pin. Specimens representing these materials may be gripped in the jaws of the testing machine. Drilling is omitted.

The specimens may be reduced in width by not more than 0.003 in. (0.08 mm.) over the center half of the gage length in order that fracture may occur there.

2SI—Chemical Compositions of Steels

[The steels shall be designated by serial number.]

The steels shall conform to the requirements as to chemical composition specified in the accompanying tables.

An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of the elements specified. The chemical composition thus determined shall be reported to the purchaser or his representative and shall conform to the requirements specified.

When electric or crucible furnace steel is specified in the order, the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

The system of numbering of the steels is the same as that of the Society of Automotive Engineers, but the composition is not always identical.

CARBON STEELS

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur maximum	Nickel	Chromium
1010.......	0.05-0.15	0.30-0.60	0.045	0.050	....	....
1015.......	.10- 20	.30- .60	.045	.050	....	....
1020.......	.15- .25	.30- .60	.045	.050	....	....
1025.......	.20- .30	.50- .80	.045	.050	....	....
1030.......	.25- .35	.50- .80	.045	.050	....	....
1035.......	.30- .40	.50- 80	.045	.050	....	....
1045.......	.40- .50	.50- .80	.045	.050	....	....
1050.......	45- .55	.50- .80	.045	050	....	....
1065.......	.60- 70	.50- .70	.040	045	....	....
1070.......	.65- .75	.50- .70	.040	.045	....	....
1080.......	.75- .90	.25- .50	040	045	....	....
1095.......	90-1 05	.25- .50	040	045	....	....

NICKEL STEELS

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum	Nickel	Chromium
2315	0 10-0 20	0.30-0.60	0.040	0 045	3.25-3.75	..
2320	20- .30	.30- .60	.040	.045	3 25-3 75	....
2325.....	20- .30	.50- .80	040	.045	3.25-3.75	....
2330	.25- .35	.50- .80	.040	.045	3.25-3.75	.. ..
2335	30- .40	.50- 80	.040	045	3.25 3 75	

NICKEL-CHROMIUM STEELS

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum	Nickel	Chromium
3120.	0.15-0.25	0.30-0.60	0 040	0 045	1.00-1.50	0 45-0.75
3130......	.25- .35	.50- .80	.040	045	1 00-1 50	.45- .75
3135......	.30- 40	.50- .80	.040	045	1 00-1 50	.45- .75
3140.	.35- .45	.50- .80	.040	045	1.00-1 50	.45- .75
3215......	.10- .20	.30- .60	.040	045	1 50 2 00	.90-1.25
3230.....	.25- .35	.30- .60	.040	045	1 50-2 00	90-1.25
3240	.35- .45	.30- .60	.040	.045	1.50-2.00	.90-1 25
X3315....	.10- .20	.30- 60	.040	045	2 75 3 25	.70- .95
X3330......	.25- .35	.45- .75	040	045	2 75-3 25	.70- .95
X3340......	.35- .45	.45- .75	.040	.045	2 75-3 25	.70- .95
3315......	.10- 20	.30- .60	.040	045	3 25-3 75	1 25-1.75
3330......	.25- .35	.30- .60	.040	045	3.25-3 75	1.25-1.75
3340......	.35- .45	.30- .60	.040	.045	3.25-3.75	1.25-1.75
X3340......	.35- .45	.30- .60	.040	045	4.00-5.00	1.00-1.50

CHROMIUM STEELS

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum	Nickel	Chromium
51100.....	0.95-1.10	0 20-0.45	0.030	0.030	None	1.30-1.50

CHROMIUM-VANADIUM STEELS

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum	Chromium	Vanadium, minimum
6120......	0.15-0.25	0.30-0 60	0.040	0 045	0 60-0 90	0.15
6130.......	.25- .35	.50- .80	.040	045	.80-1 10	.15
6140:......	35- .45	.50- .80	.040	.045	.80-1.10	.15
6150	.45- .55	.50- .80	.040	.045	.80-1.10	.15

TUNGSTEN STEELS

Number	Carbon	Manganese, maximum	Phosphorus, maximum	Sulphur, maximum	Chromium	Tungsten
W60.....	0 50-0 70	0.30	0.035	0 035	3 00-4 00	13 00-15.00
W60a.....	.50- 70	.30	.035	.035	3 00-4 00	16.00-18.00
W60b.....	.50- 70	30	.035	.035	.50-1 00	1.50 -2 00

3SI—Specifications for Carbon Steel Bars and Billets for Case-Hardening

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The material for these bars shall be chosen from among the standard I. A. S. B. steels listed below. The composition chosen shall be stated by the manufacturer or contractor; it shall be further limited as follows: Carbon, not over 0.25 per cent.

MANUFACTURE.—3. (*a*) The steel shall be manufactured, or at least finished, by the open-hearth, electric furnace, or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar. No undercutting in chipping will be allowed.

(*d*) The steel manufacturer shall state the heat treatment recommended for case hardening this steel, and to give the physical properties specified.

WORKMANSHIP AND FINISH.—4. (*a*) The bars are to be sound, commercially straight, free from pipes, laps, cracks, twists, seams, voids, and damaged ends, and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture, capable of being turned and threaded readily, and of taking a good finish.

(*b*) Any article may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously passed the physical and chemical tests; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

PHYSICAL PROPERTIES AND TESTS—5. The bars shall have the following physical properties:

Tensile Test.—(*a*) Minimum tensile strength, 70,000 lbs. per sq. in. (49.21 kg./sq. mm.). Minimum yield point, 45,000 lbs. per sq. in. (31.64 kg./sq. mm.). Minimum yield point, 45,000 lb. per sq. in. (31.64 kg./sq. mm.). Minimum elongation in 2 in. (50.8 mm.), or proportional gage length, 20 per cent.

Hardness.—(*b*) After carbonizing, hardening, and tempering, the case must show a minimum Shore Scleroscope hardness number of 75.

Impact.—(*c*) In all cases in which impact testing machines of the pendulum type are available, tests will be carried out to determine the specific impact work of rupture of the core in foot-pounds (or kilogram-meters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Selection of Test Specimens—6. Three bars of each size rolled from a heat shall be taken and test pieces prepared in accordance with the I. A. S. B. standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces after being heat treated in the manner recommended by the steel manufacturer fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser the steel manufacturer may recommend a different heat treatment for the second set of test specimens and to that end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the final tests fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected.

Dimensions and Tolerances—7. The dimensions and tolerances shall be those given by the specifications 3S11.

Delivery, Packing and Shipping—8. (*a*) The bars may be delivered in the annealed or in the heat-treated condition.

(*b*) The bars shall in general be grouped in bundles weighing not more than 250 lbs. (113.4 kg.), unless otherwise agreed between manufacturer and purchaser; the heat and the I. A. S. B. steel serial number shall be plainly marked on a metal tag attached to each bundle. If bars are not so grouped and bundled, each bar shall be plainly marked with the heat number and the I. A. S. B. steel and serial number.

Compositions of Standard Steels.

Number.	Carbon.	Manganese.	Phosphorus, Maximum.	Sulphur, maximum.
1010	0.05-0.15	0.30-0.60	0.015	0.050
1015	.10- .20	.30- .60	.045	.050
1020	.15- .25	.30- .60	.045	.050

When electric or crucible furnace steel is specified in the order, the maximum allowable percentage of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

3S2—Specifications for Medium Carbon Steel Bars and Billets

General—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material—2. The I. A. S. B. standard steel No. 1035 shall be used; its composition is as follows: Carbon, 0.30-0.40; manganese, 0.50-0.80; phosphorus, maximum, 0.045; sulphur, maximum, 0.050.

When electric or crucible furnace steel is specified in the order, the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

Manufacture—3. (*a*) The steel shall be manufactured, or, at least finished by the open-hearth, electric furnace, or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar or forging. No undercutting in chipping will be allowed.

Heat Treatment.—(*d*) The manufacturer shall state the heat treatment recommended to give physical properties specified.

(*e*) If the bars are delivered in the heat-treated condition, and the physical tests show that the heat treatment has not been correct, the bars may be retreated at the option of the purchaser.

Workmanship and Finish—4. (*a*) The bars are to be sound, commercially straight, free from pipes, laps, cracks, twists, seams, voids, and damaged ends and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture, capable of being turned and threaded readily and of taking a good finish.

(*b*) Any article may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously passed the physical and chemical tests; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests—5. The bars shall have the following physical properties.

Tensile Test.—(*a*) Minimum tensile strength, 80,000 lbs. per sq. in. (56.24 kgs. per sq. mm.); minimum yield point, 60,000 lbs. per sq. in. (42.18 kgs. per sq. mm); minimum elongation in 2 in. (50.8 mm.) or proportional gage length, 22 per cent; minimum reduction of area, 45 per cent.

Impact Test.—(*b*) In all cases in which impact testing machines of the pendulum type are available, tests may be carried out to determine the specific impact work of rupture in foot-pounds (or kilogram-meters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Selection of Test Specimens.—6. Three bars of each size rolled from a heat shall be taken and test pieces prepared in accordance with the I. A. S. B. standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended by the steel manufacturer, fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser the steel manufacturer may prescribe a different heat treatment for the second set of test specimens, and to that end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the final tests fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected. Where bars are purchased in the heat-treated condition, test specimens shall be cut from the heat-treated bar.

Dimensions and Tolerances.—7. The dimensions and tolerances shall be those given in the specification 3S11.

Delivery, Packing and Shipping.—8. (*a*) The bars may be delivered in the annealed or in the heat-treated condition.

(*b*) The bars shall, in general, be grouped in bundles weighing not more than 250 lb. (113.4 kg.), unless otherwise agreed between manufacturer and purchaser. The heat and the I. A. S. B. steel serial numbers shall be plainly marked on a metal tag attached to each bundle. If bars are not so grouped and bundled, each bar shall be plainly marked with the heat number and the I. A. S. B. steel and serial number.

3S3—Specifications for Alloy Steel Bars and Billets

(100,000 Lb. Per Sq. In. Tensile Strength)

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. The material for these bars shall be chosen from among the I. A. S. B. standard alloy steels listed below. The composition chosen shall be stated by the manufacturer or contractor, and is further limited as follows: Carbon, not over 0.35 per cent.

Manufacture.—3. (*a*) The steel shall be manufactured or at least finished by the open-hearth electric furnace or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar. No undercutting in chipping will be allowed.

Heat Treatment.—(*d*) The steel manufacturer shall state the heat treatment recommended to give the physical properties specified.

(*e*) If the bars are furnished in the heat-treated condition and the physical tests show that the heat treatment has not been correct, the bars may be retreated at the option of the purchaser.

Workmanship and Finish.—4. (*a*) The bars are to be sound, commercially straight, free from pipes, laps, cracks, twists, seams, and damaged ends, and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture, capable of being turned and threaded readily, and of taking a good finish.

(*b*) Any article may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously passed the physical and chemical tests; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—5. (*a*) The bars shall have the following physical properties:

Tensile Test.—(*b*) Minimum tensile strength, 100,000 lb. per sq. in. (70.30 kg./mm.^{2}); minimum yield point, 80,000 lb. per sq. in. (56.24 kg./mm.^{2}); minimum elongation in 2 in. (50.8 mm.) (or proportional gage length), 20 per cent; minimum reduction of area, 50 per cent.

Impact Test.—(*c*) When impact-testing machines of the pendulum type are available tests shall be carried out if required to determine the specific impact work of rupture in foot-pounds (or kilogram-meters). Results markedly lower than the average, for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Selection of Test Specimens.—(*d*) Three bars of each size rolled from a heat shall be taken and test pieces prepared in accordance with the I. A. S. B. standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended by the steel manufacturer, fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars.

At the option of the purchaser the steel manufacturer may recommend a different heat treatment for the second set of test specimens, and to that end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the final tests fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected. When bars are purchased in the heat-treated condition, test specimens shall be cut from the heat-treated bar.

Dimensions and Tolerances.—6. The dimensions and tolerances shall be those given in the Specification 3S11.

Delivery, Packing and Shipping.—7. (*a*) The bars may be delivered in the annealed or in the heat-treated condition.

(*b*) The bars shall in general be grouped in bundles weighing not more than 250 lb. (113.4 kg.), unless otherwise agreed between manufacturer and purchaser. The heat number and the I. A. S. B. steel serial number shall be plainly marked on a metal tag attached to each bundle. If bars are not so grouped and bundled, each bar shall be plainly marked with the heat number and the I. A. S. B. steel serial number.

3S16—Specifications for Iron or Steel Wire for Acetylene Welding

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. (*a*) The material from which the wire is manufactured shall be made by any approved process "Genuine Norway iron" will be accepted for the purpose.

(*b*) The iron or steel shall conform to the following chemical analysis: Carbon, not more than 0.08 per cent; manganese, not more than 0.15 per cent; sulphur, not more than 0.025 per cent; phosphorus, not more than 0.02 per cent.

Workmanship and Finish.—3. The surface of the wire shall be smooth and free from scale and pits; rusty and scraped wire will not be accepted.

Physical Properties and Tests.—4. A dead soft wire is not desired. In order to detect wire of this kind, one to three samples shall be selected from each 10,000 (4,536 kg.) or less submitted for inspection, and a test made for elongation on a gage length of 10 in. (254 mm.). When two or more samples show an elongation greater than 5 per cent the wire shall be rejected.

Dimensions and Tolerances.—5. (*a*) All wire for this purpose shall have the size specified on orders in decimal parts of an inch (or millimeter). The wire shall be supplied, inspected and reported in the same manner.

(*b*) Great accuracy in gage is not necessary, but no wire varying more than 3 per cent plus or minus shall be accepted.

Delivery, Packing, and Shipment.—6. (*a*) Steel wire for use in acetylene welding shall be furnished in coils or straightened and cut to lengths as required.

(*b*) If not furnished in coils, the wire, straightened and cut to 36-in. (914 mm.) length, plus or minus 1 in. (25.4 mm.), shall be packed in bundles weighing from 50 to 75 lb. (22.68 kg. to 34.02 kg.) each and securely tied with two or more wire bands.

(*c*) All bundles shall be burlapped all over for shipment, and shall be marked with a metal tag containing the name of the manufacturer, the size, length of the contents, and the inspection mark.

Inspection and Rejection.—7. Inspection for gage, finish, and chemical analysis shall be made on this wire before cutting it into straightened lengths. The wire shall then be cut to length, and subsequent optional check inspection may be made by the Government Inspector at the plant of the manufacturer.

3S4—Specifications for Alloy Steel Bars and Billets

(125,000 Lb. Per Sq. In. Tensile Strength)

General.—The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. The material for these bars shall be chosen from among the I. A. S. B. standard alloy steels listed below. The composition chosen shall be stated by the manufacturer or contractor and is further limited as follows: Carbon, not over 0.40 per cent.

Chemical composition of standard alloy steels.

NICKEL STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium.
2320	0.15-0.25	0.30-0.60	0.040	0.045	3.25-3.75	....
2325	.20- .30	.50- .80	.040	.045	3.25-3.75	....
2330	.25- .35	.50- .80	.040	0.45	3.25-3.75	....

NICKEL-CHROMIUM STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium.
3120	0.15-0.25	0.30-0.60	0.040	0.045	1.00-1.50	0.45-0.75
3130	.25- .35	.50- .80	.040	.045	1.00-1.50	.45- .75
3230	.25- .35	.30- .60	.040	.045	1.50-2.00	.90-1.25
X3315	.10- .20	.30- .60	.040	.045	2.75-3.25	.70- .95
X3330	.25- .35	.45- .75	.040	.045	2.75-3.25	.70- .95
3315	.10- .20	.30- .60	.040	.045	3.25-3.75	1.25-1.75
3330	.25- .35	.30- .60	.040	.045	3.25-3.75	1.25-1.75

CHROMIUM VANADIUM STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Chromium.	Vanadium, minimum.
6120	0.15-0.25	0.30-0.60	0.040	0.045	0.60-0.90	0.15
6130	.25- .35	.50- .80	.040	.045	.80-1.10	.15

When electric or crucible furnace steel is specified in the order, the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

Manufacture.—3. (*a*) The steel shall be manufactured or at least finished by the open-hearth, electric furnace, or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar. No undercutting in chipping will be allowed.

Heat Treatment.—(*d*) The steel manufacturer shall state the heat treatment recommended to give the physical properties specified.

(*e*) If the bars are furnished in the heat-treated condition and the physical tests show that the heat treatment has not been correct, the bars may be re-treated at the option of the purchaser.

Workmanship and Finish.—4. (*a*) The bars are to be sound, commercially straight, free from pipes, laps, cracks, twists, seams, and damaged ends, and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture, capable of being turned and threaded readily and of taking a good finish.

(*b*) Any article may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously passed the physical and chemical tests; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—5. (*a*) The bars shall have the following physical properties:

Tensile Test.—(*b*) Minimum tensile strength, 125,000 lb. per sq. in. (87.88 kg./mm.^{2}); minimum yield point, 95,000 lb. per sq. in. (66.79 kg./mm.^{2}); minimum elongation in 2 in. (50.8 mm.) (or proportional gage length), 17 per cent; minimum reduction of area, 50 per cent.

Impact Test.—(*c*) When impact-testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture in foot-pounds (or kilogram-meters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Selection of Test Specimens.—(*d*) Three bars of each size rolled from a heat shall be taken, and test pieces prepared in accordance with the I. A. S. B. standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended by the steel manufacturer, fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser the steel manufacturer may recommend a different heat treatment for the second set of test specimens, and to that end he may make such tests as he desires from the remainder of the three bars taken for the test. Should any of the three specimens taken for the final tests fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected. When bars are purchased in the heat-treated condition, test specimens shall be cut from the heat-treated bar.

Dimensions and Tolerances.—6. The dimensions and tolerances shall be those given in the Specification 3S11.

Delivery, Packing and Shipping.—8. (*a*) The bars may be delivered in the annealed or in the heat-treated condition.

(*b*) The bars shall in general be grouped in bundles weighing not more than 250 lb. (113.4 kg.), unless otherwise agreed between manufacturer and purchaser. The heat number and the I. A. S. B. steel serial number shall be plainly marked on a metal tag attached to each bundle. If bars are not so grouped and bundled, each bar shall be plainly marked with the heat number and the I. A. S. B. steel serial number.

Chemical compositions of standard alloy steels.

NICKEL STEELS

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum	Nickel	Chromium
2320	0.15- .25	0.30- .60	0.040	0.045	3.25-3.75	....
2325	.20- .30	.50- .80	040	.045	3.25-3.75	....
2330	.25- .35	.50- .80	040	.045	3.25-3.75	....
2335	.30- .40	.50- .80	040	.045	3.25-3.75	....

NICKEL-CHROMIUM STEELS

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum	Nickel	Chromium
3130	0.25-0.35	0.50-0.80	0.040	0.045	1.00-1.50	0.45-0.75
3135	.30- .40	.50- .80	.040	.045	1.00-1.50	.45- .75
3230	.25- .35	.30- .60	.040	.045	1.50-2.00	.90-1.25
X3315	.10- .20	.30- .60	.040	.045	2.75-3.25	.70- .95
X3390	.25- .35	.45- .75	.040	.045	2.75-3.25	.70- .95
3315	.10- .20	.30- .60	.040	.045	3.25-3.75	1.25-1.75
3330	.25- .35	.30- .60	.040	.045	3.25-3.75	1.25-1.75

CHROMIUM VANADIUM STEELS

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum	Chromium	Vanadium, minimum
6130	0.25-0.35	0.50-0.80	.040	0.045	0.80-1.10	0.15

When electric or crucible furnace is specified in the order, the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

3S17—Specifications for Steel Wire for Electric Welding

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. (*a*) The material from which the wire is manufactured shall be made by any approved process.

(*b*) The I. A. S. B. standard steel No. 1015 shall be used; a carbon content of from 0.13 to 0.18 per cent is desired.

Workmanship and Finish.—3. (*a*) Electric welding wire shall be of the quality and finish known as "Bright," "Bright Hard," or "Soft Finish." "Black Annealed" or "Bright Annealed" wire shall not be supplied.

(*b*) The surface shall be free from scale, lime, copper, or other metals. A moderate coating of rust or of lubricant used in the drawing of the wire is permissible.

Physical Properties and Tests.—4. A dead soft wire is not desired. In order to detect wire of this kind, from one to three samples shall be selected from each 10,000 lb. (4536 kg.) or less submitted for inspection, and a test made for elongation (in tension) over a gage length of 10 in. (254 mm.). When two or more samples show an elongation greater than 5 per cent the wire shall be rejected.

Dimensions and Tolerances.—5. (*a*) All wire for this purpose shall have the size specified on orders in decimal parts of an inch (or millimeter). The wire shall be supplied, inspected and reported in the same manner.

(*b*) Great accuracy in gage is not necessary, but no wire varying more than 3 per cent plus or minus shall be accepted.

Delivery, Packing, and Shipping.—6. (*a*) Steel wire for use in electric welding shall be furnished in coils or straightened and cut to lengths as required.

(*b*) If not furnished in coils, the wire, straightened and cut to 36-in. (914 mm.) lengths, plus or minus 1 in. (25.4 mm.), shall be packed in bundles weighing from 50 to 75 lb. (22.68 kg. to 34.02 kg.) each and securely tied with two or more wire bands.

(*c*) All bundles shall be burlapped all over for shipment, and shall be marked with a metal tag containing the name of the manufacturer, the size, length of contents, and the inspection mark.

Inspection and Rejection.—7. Inspection for gage, finish, and chemical analysis shall be made on this wire before cutting it into straightened lengths. The wire shall then be cut to length, and subsequent optional check inspection may be made by the Government inspector at the plant of the manufacturer.

3S5—Specifications for Alloy Steel Bars and Billets

(150,000 Lb. Per Sq. In. Tensile Strength)

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. The material for these bars shall be chosen from among the I. A. S. B. standard alloy steels listed below. The composition chosen shall be stated by the manufacturer or contractor, and is further limited as follows: Carbon, not over 0.45 per cent.

Manufacture.—3. (*a*) The steel shall be manufactured or at least finished by the open-hearth electric furnace, or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar. No undercutting in chipping will be allowed.

Heat Treatment.—(*d*) The steel manufacturer shall state the heat treatment recommended to give the physical properties specified.

(*e*) If the bars are furnished in the heat-treated condition and the physical tests show that the heat treatment has not been correct, the bars may be retreated at the option of the purchaser.

Workmanship and Finish.—4. (*a*) The bars are to be sound, commercially straight, free from pipes, laps, cracks, twists, seams, and damaged ends, and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture, capable of being turned and threaded readily and of taking a good finish.

(*b*) Any article may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously passed the physical and chemical tests; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—5. (*a*) The bars shall have the following physical properties:

Tensile Test.—(*b*) Minimum tensile strength, 150,000 lb. per sq. in. (105.45 kg./mm.^{2}); minimum yield point, 115,000 lb. per sq. in. (80.85 kg./mm.^{2}); minimum elongation in 2 in. (50.8 mm.) (or proportional gage length), 14 per cent; minimum reduction of area, 45 per cent.

Impact Test.—(*c*) When impact-testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture in foot-pounds (or kilogram-meters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Selection of Test Specimens.—(*d*) Three bars of each size rolled from a heat shall be taken, and test pieces prepared in accordance with the I. A. S. B. standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended by the steel manufacturer, fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser the steel manufacturer may recommend a different heat treatment for the second set of test specimens, and to that end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the final tests fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected.

Dimensions and Tolerances.—6. The dimensions and tolerances shall be those given in the Specification 3S11.

Delivery, Packing and Shipping.—7. (*a*) The bars may be delivered in the annealed or in the heat-treated condition.

(*b*) The bars shall in general be grouped in bundles weighing not more than 250 lb. (113.4 kg.), unless otherwise agreed between manufacturer and purchaser. The heat number and the I. A. S. B. steel serial number shall be plainly marked on a metal tag attached to each bundle. If bars are not so grouped and bundled, each bar shall be plainly marked with the heat number and the I. A. S. B. steel serial number.

Chemical compositions of standard alloy steels.

NICKEL STEELS

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum	Nickel	Chromium
2325	0.20-0.30	0.50-0 80	0 040	0 045	3.25-3.75	....
2330	.25- .35	.50- 80	040	.045	3 25-3.75	....
2335	.30- .40	.50- .80	040	.045	3.25-3.75	....

NICKEL-CHROMIUM STEELS

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum	Nickel	Chromium
3130	0.25-0.35	0.50-0.80	0 040	0.045	1.00-1.50	0.45-0 75
3135	.30- .40	.50- .80	.040	.045	1.00-1.50	.45- 75
3140	35- .45	.50- 80	.040	.045	1.00-1.50	.45- .75
3230	.25- .35	.30- 60	.040	.045	1.50-2.00	.90-1.25
3240	.35- .45	.30- .60	.040	.045	1.50-2.00	.90-1.25
X3330	.25- 35	.45- .75	.040	.045	2.75-3 25	.70- .95
X3340	.35- .45	.45- .75	.040	.045	2.75-3.25	.70- .95
3330	.25- .35	.30- .60	.040	.045	3.25-3.75	1.25-1.75
3340	.35- 45	30- .60	.040	.045	3.25-3.75	1.25-1.75
X3440	.35- .45	.30- .60	.040	.045	4 00-5.00	1 00-1.50

CHROMIUM VANADIUM STEELS

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum	Chromium	Vanadium, minimum
6130	0 25-0.35	0 50-0 80	0.040	0.045	0.80-1.10	0.15
6140	.35- .45	.50- .80	.040	0.045	.80-1.10	.15

When electric or crucible furnace steel is specified in the order the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

3S6—Specifications for Alloy Steel Bars and Billets

(175,000 Lb. Per Sq. In. Tensile Strength)

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. The material for these bars shall be chosen from among the I. A. S. B. standard alloy steels listed below. The composition chosen shall be stated by the manufacturer or contractor, and is further limited as follows: Carbon, not over 0.45 per cent.

Manufacture.—3 (*a*) The steel shall be manufactured or at least finished by the open-hearth, electric-furnace, or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar. No undercutting in chipping will be allowed.

Heat Treatment.—(*d*) The steel manufacturer shall state the heat treatment recommended to give the physical properties specified.

(*e*) If the bars are furnished in the heat-treated condition and the physical tests show that the heat treatment has not been correct, the bars may be retreated at the option of the purchaser.

Workmanship and Finish.—4. (*a*) The bars are to be sound, commercially straight, free from pipes, laps, cracks, twists, seams, and damaged ends, and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture, capable of being turned and threaded readily and of taking a good finish.

(*b*) Any article may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously passed the physical and chemical tests; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—5. (*a*) The bars shall have the following physical properties:

Tensile Test.—(*b*) Minimum tensile strength, 175,000 lb. per sq. in. (123.03 kg./mm.^{2}); minimum yield point, 150,000 lb. per sq. in. (105.45 kg./mm.^{2}); minimum elongation in 2 in. (50.8 mm.) (or proportional gage length), 12 per cent; minimum reduction of area, 40 per cent.

Impact Test.—(*c*) When impact-testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture in foot-pounds (or kilogrammeters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Selection of Test Specimens.—(*d*) Three bars of each size rolled from a heat shall be taken and test pieces prepared in accordance with the I. A. S. B. standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended by the steel manufacturer, fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser the steel manufacturer may recommend a different heat treatment for the second set of test specimens, and to that end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the final tests fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected.

Dimensions and Tolerances—6. The dimensions and tolerances shall be those given in the Specification 3S11.

Delivery, Packing and Shipping.—7. (*a*) The bars may be delivered in the annealed or in the heat-treated condition.

(*b*) The bars shall in general be grouped in bundles weighing not more than 250 lb. (113.4 kg.), unless otherwise agreed between manufacturer and purchaser; the heat number and the I. A. S. B. steel serial number shall be plainly marked on a metal tag attached to each bundle. If bars are not so grouped and bundled, each bar shall be plainly marked with the heat number and the I. A. S. B. steel serial number.

Chemical compositions of standard alloy steels.

NICKEL STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium.
2330	0.25-0.35	0.50-0.80	0.040	0.045	3 25-3.75	....
2335	.30- .40	.50- .80	.040	0 45	3.25-3.75	....

NICKEL-CHROMIUM STEELS

Number.	Carbon.	Manganese.	Phosphorus maximum.	Sulphur, maximum.	Nickel.	Chromium.
3135	0.30-0.40	0.50-0.80	0.040	0.045	1.00-1.50	0.45-0.75
3230	.25- .35	.30- .60	.040	0 45	1 50-2 00	.90-1.25
3240	.35- 45	.30- .60	.040	.045	1 50-2.00	.90-1.25
X3330	.25- 35	.45- .75	.040	.045	2.75-3.25	.70- .95
X3340	.35- 45	.45- .75	.040	.045	2.75-3.25	.70- .90
3330	35- .35	.30- .60	.040	045	3.25-3.75	1.25-1.75
3340	.35- .45	.30- .60	.040	.045	3.25-3.75	1.25-1.75
X3440	.35- .45	.30- .60	.040	.045	4.00-5 00	1.00-1.50

CHROMIUM-VANADIUM STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Chromium.	Vanadium, minimum.
6130	0.25-0 35	0 50-0 80	0 040	0.045	0.80-1.10	0.15
6140	.35- 45	.50- 80	.040	045	.80-1.10	.15

When electric or crucible furnace steel is specified in the order, the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

Additional specifications issued by the International Aircraft Standards Board will be printed in the next issue of Aviation and Aeronautical Engineering.

Major Wadsworth at League Island

Maj. George R. Wadsworth, U. S. A., who since the death of Maj. Henry South has been in charge of the Langley Field Experiment Station, is at present serving as chief engineer at the Naval Aircraft Factory, League Island Navy Yard, Philadelphia, Pa.

Technical Reports of the S. A. E. Standards Committee

At the sessions of the Society of Automotive Engineers, Aeronautical Standards Committee, held on Sept. 30 and Oct. 1 at the Bureau of Standards, a number of standards for airplane fittings was reported and discussed.

The meeting, which was called at the request of the Aircraft Production Board of the Council of National Defense, was opened Sunday with C. F. Clarkson, general manager of the S. A. E. in the chair.

A general talk on aircraft standards was made by Howard C. Coffin, chairman of the Aircraft Production Board. Subcommittee assignments were then given out and the meeting broke up into the sessions of the several sub-committees.

On Monday, Charles M. Manly of the Curtiss Company opened the meeting and called for reports as chairman of the session. M. W. Hanks, standards manager of the S. A. E., made his report and assisted in the transaction of the business of the committees reporting.

During the sessions of the Bureau of Standards the Society of Automotive Engineers Aeronautical Standards Committee recommended the following standards:

Airplane stick control, airplane wheel control. Ball and roller bearings, clip ends, clevis pins, cotter pins. Engine supports. Ferrules. Loops (see Wire Ends). Magneto dimensions, 4 and 6-cylinder engines, magneto dimensions, 8 and 12-cylinder engines. Marking of pipe lines. Measurements, English decimal; measurements, gage number elimination. Propeller shaft end. Screws and bolts (for engines), screws and bolts (for aircraft), screws and bolts (for aircraft, plain hex head), screws and bolts (for aircraft, ball hex head), screws and bolts (for aircraft, Castle hex nut), screws and bolts (for plain ball hex nut), screws and bolts (for Castle ball hex nut). Shackles. Spark plug shells.

Test specimens, round tension; test specimens, flat tension; test specimens, gray cast iron, molding specimen; test specimen, gray cast iron, test specimen; test specimens, shock. Steel, carbon steel, screw stock; steel, casting steel; steel, nickel chromium; steel, chromium vanadium; steel, silico manganese, steel, nickel steel; heat treatment. System of measurement (see Measurements). Thimbles. Throttle levers. Turnbuckles. Wire and cable ends, round wire; wire and cable ends, non-flexible cable, and wire and cable ends, flexible cable.

The followings standards were recommended to the Society of Automotive Engineers by the Aeronautical Division:

Radiator and jacket connection, hose clamp; reels for aircraft wire; specification, testing and inspection, and tension, wire and cable; high strength steel wire, 19 non-flexible steel wire cable, 7 x 7 flexible steel wire cable and 7 x 19 extra flexible steel wire cable.

These, however, have not yet been approved by the Society of Automotive Engineers as a whole.

Work now in progress by Aeronautical Division of the Society of Automotive Engineers includes the following. Reports on those preceded by an asterisk (*) were made at the recent meeting. The number in parentheses following an item indicates the percentage of work now completed:

* Dope and varnish (80). Engine rotation. Engine testing forms. * Engine weight specifications (80). * Glue (9), heat treatment of frame joints. Hand air pumps, inspection methods. Wire ends, stream-line wire. Machine gun mounting. Marking spark and throttle levers. Nomenclature. * Pipe fittings, fuel (75); pipe fittings, oil; pipe fittings, air. * Pontoon fittings (75). * Propeller-hub lock fittings. Propeller-hub rating, propeller stress. * Radiator and jacket connection, hose (75). * Safety belts (75). * Screws and bolts, eye bolts (90); screws and bolts, fine threads, small and large diameter. Screw thread gages. * Spark plug shells, hex, chamfer, etc. (90). Specifications, testing, inspecting. Non-ferrous alloys, brass, bronze, aluminum. Specifications, testing and inspecting. Steel alloys, screw stock, sheets, tubing, bars. Specifications, testing and inspection. * Tension, wire and cable (90). Tension, stream-line wire. * Tachometer connections. * Turnbuckles, dimension (90). Turnbuckles, safety wires. Twin carbureter flanges. * Washers, plain (98); * washers, bevel (98). * Wheels (75), hubs, spokes, rims, tires. * Wing attachments (75).

The following is a summary of the reports made at the meeting:

Magneto Dimensions

A report on magneto dimensions submitted by A. D. T. Libby simply recommended that the depth of the dowel pin hole be changed from ½ in. to 5/16 in., and that the width of the magneto space be increased from 5 in. to 6½ in.

Varnish Specifications

The report of the Varnish Committee was read by Percy K. Walker of the Bureau of Standards, the following recommendations were made for varnish specifications, the varnish being intended for application to both spars and wings of airplanes:

"The material shall be the best long oil varnish, resistant to air, light and water. The manufacturer is given the greatest latitude in the selection of raw materials and process of manufacture in order to produce a product of the highest quality.

"The material shall comply with the following requirements: It shall be clear and transparent. Its color shall be no darker than a standard color solution made by dissolving 6 g. of pure powdered potassium bichromate in 100 cc. of pure concentrated sulphuric acid (specific gravity 1.84). Gentle heat may be used, if necessary, to secure a perfect solution of the bichromate. The color comparison will be made by placing the varnish and the standard color solution in clear, thin-walled glass tubes of the same diameter, 1.5 to 2 cm. (⅝ to 13/16 in.) to a depth of at least 2.5 cm. (1 in.) and comparing the colors by looking through the tubes across the column of the liquid by transmitted light. It shall not flash below 35 deg. C. (95 deg. F.) in an open tester.

"When flowed on a glass plate held in a vertical position and maintained at a temperature of 21 deg. to 32 deg. C. (70 deg to 90 deg. F.) it shall set to touch at a point not less than 2.5 cm. (1 in.) from the side or top edges of the film, in not more than 5 hours; and shall dry hard in not more than 24 hours to a clear, hard, glossy and elastic film.

"A coat of varnish will be flowed onto either black iron or tinplate coated with a good quality of good baking japan, allowing to dry 48 hours in a vertical position and then immersing in boiling water for one hour. The water will be siphoned through a small glass tube directly from a container in which it is boiling, onto the surface of the panel, in such a manner that there will be no appreciable lowering of the temperature of the water before it touches the varnish film. The siphon delivery tube will be in a plane nearly parallel to the plane of the panel, so that the impact of the water will not tend to break the film. The varnish shall show no appreciable whitening and no more than a very slight dulling.

FLEXIBILITY TEST

"The varnish shall be flowed on one side of a piece of terne plate 10 by 15 cm. (4 in. by 6 in.), which has been previously thoroughly cleaned with benzol. The coating must extend entirely across the width of the plate and for at least 14 cm. (5½ in.) of the length. The plate shall then be held in a vertical position for 6 hours at room temperature (21 deg. C. to 32 deg. C.) (70 deg. to 90 deg. F.). It shall then be placed in an oven at a temperature not less than 135 deg. C. (275 deg. F.) or more than 149 deg. C. (300 deg. F.) for 17 hours. It will then be removed from the oven, kept at a temperature between 21 deg. C. (70 deg. F.) and 32 deg. C. (90 deg. F.) for not less than 6 nor more than 24 hours. The panel with the varnished side on the outside will then be rapidly bent double over a rod 3 mm. (⅛ in.) in diameter at a point not less than 5 cm. (2 in.) or more than 7.5 cm. (3 in.) from the bottom of the plate. The varnish film shall show no cracking or flaking at the point of bending.

ENDURANCE TEST

"The varnish will be applied in three coats to two unfilled panels of maple wood. Each coat will be allowed to dry indoors for 3 days and will then be lightly sandpapered before the application of the next coat. The final coat will not be sandpapered or rubbed, and the duplicate panels will be exposed outdoors, 45 deg. to the vertical, facing south, 3 days after the application of the finishing coat. The backs and edges of the panels will also be varnished with the same sample, but for these surfaces the details of the method of application as given need not be adhered to, and the effects of exposure on these surfaces will not be considered. On this test the varnish shall show satisfactory durability and weather resisting properties. In cases where the award of a contract cannot be delayed for the results of the exposure test, award may be made on the basis of the other requirements; but a varnish of any specific brand which does not show up satisfactorily on an exposure test may be omitted from consideration in future awards, and a preliminary submittal of samples for making exposure tests may be called for."

Dopes

Dopes for airplane fabrics must consist of a clear, uniform mixture of ingredients and be capable of shrinking the fabric to the degree of tautness desired by the signal corps inspection. The residual film should give a smooth, homogeneous surface when applied in a horizontal position in an atmosphere not exceeding 65 deg. humidity and 75 deg. F. temperature, free from direct draft. Besides celluloid acetate there are nitrated dopes, and the above requirements apply also to the latter.

The viscosity of the dope must permit of direct application without dilution at a temperature not lower than 60 deg. F. (Applies also to nitrate dopes.)

The dope, when dry, must adhere to the fabric with sufficient tenacity to prevent peeling off in sheets. Test strips should show lint attached to the side which has been in contact with the fabric. (This specification applies also to nitrate dopes.)

Four coats, or an equivalent of the dope, 48 hours after application, must increase the tensile strength of linen fabrics not less than 25 per cent of the original strength, and of cotton fabrics not less than 15 per cent. The increase in weight per square yard of doped fabric should not be less than 2 oz. nor greater than 3.5 oz. The test shall be made under standard conditions of humidity and temperature. (Applies also to nitrate dopes.)

No mineral acids may be present in the dope, and the amount of free organic acidity figured as acetic acid may not exceed 0.2 per cent. No compounds may be present which would be injurious to the fabric. (Also holds for nitrate dopes.)

Dopes which show the presence of free sulphuric acid or sulphates by the test given below are not acceptable. (Omitted in specification for nitrate dopes.)

Dopes containing tetrachlorethane are not acceptable. (Omitted for nitrate dopes.)

The cellulose acetate used should be neutral and stable and completely soluble in acetone. The amount of cellulose acetate should be not less than 60 grams per liter.

EXPOSURE TEST

The volatile solvents employed should present no danger to the workmen applying them. (Applies also to nitrate dopes.)

Five drops of gasoline dropped on the film which has been dried for 48 hours and immediately ignited should have no more serious effect than to char the fabric under the moistened section of the film. (Omitted from specification for nitrate dopes.)

Dopes must comply with the following test: A square frame, 12 in. by 12 in. inside measurement, is covered on both sides with fabric, the fabric being tacked to the outer side of the frame. The fabric is to be tacked under uniform tension, simulating that employed in airplane manufacture. Four coats or an equivalent of dope are to be applied to each side of the frame, each coat being allowed thoroughly to dry before the succeeding coat is applied. The frames are to be exposed on a roof in an unshaded horizontal position. After 60 days of constant exposure no spontaneous cracking of the doped surface should be apparent, and after one hour at a temperature of 70 deg. to 80 deg. F. the film shall not crack and shall have a decided ring. This test shall be made comparatively with a dope that has previously passed the test. (Applies also to nitrate dopes.)

Dope shall be shipped in metal cans, metal or wooden barrels or earthenware containers. Inspection of the containers shall be permitted to insure against the introduction of foreign material. The container shall be marked with the date of manufacture, serial number, gross tare and net weight. (Applies also to nitrate dopes.)

FILTRATION TEST.

A 500-cc. beaker, containing about 200 cc. of water, is counterbalanced on a large balance. The balance is adjusted to one-hundredth gram by adding or removing water. About 10 grams of dope are poured into the water and the increase in weight noted. This is rapidly done to 0.01 gram to diminish solvent loss. The dope is stirred up and allowed to stand 10 to 15 minutes with occasional stirring. The liquid is decanted through a rather porous filter into an 800-cc. beaker and 150 cc. of warm water added to the residue. It is allowed to stand 10 to 15 minutes with frequent stirring and poured through the filter into the 800-cc. beaker. The residue is washed with 150 cc. of warm water as before. A few drops of phenolphthalein are added and the solution titrated with tenth-normal caustic soda to a color that persists for one-half minute.

Some dopes, notably those containing much acetone, when poured into water precipitate as a milky solution containing shreds of the acetate. The resulting liquor filters slowly and passes through the filter paper in a cloudy condition. Since the acetate is finely divided, it is practically free from acetic acid and additional washing is unnecessary. The end-point is not quite as sharp as when all the acetate has been removed, owing to hydrolysis of the suspended material, but is sufficiently accurate for all practical purposes. Absence of mineral acids must be proved by qualitative tests.

SULPHATE TEST.

Twenty grams of cellulose acetate are allowed to remain at the temperature of the steam bath for 24 hours. The resulting liquor is filtered and tested for sulphates. (Omitted from specification for nitrate dopes.)

Pour 100 grams of the dope into 300 grams of 95 per cent alcohol, stirring constantly. Filter the precipitate on a Buchner funnel and dry at room temperature. Extract in a soxhlet with ether until all extractive material has been removed and dry at 60 deg. C. to constant weight.

Pour some of the dope on a glass plate and allow to dry spontaneously. The film may be examined for the general characteristics of transparency, coherence, strength and flexibility.

Engine Weight Specifications

The report submitted by John R. Cautley was not acted on at the meeting. The form for engine weight specifications as submitted was as follows:

ENGINE WEIGHT SPECIFICATIONS

Manufacturer ....
Model ....
Bore ....in. ....mm. Stroke ....in. ....mm.
No. of cyl....................Type......................
Piston displacement ....cu. in. ....liters
Compression ratio...................
Horsepower ....at .........R.P.M. (H.P. Computed at standard barometric pressure 29.92 in. (76 cm.) 32 deg. F. (0°C) 45°.
Gasoline Consumption .... lbs.........kilos. per hour at above H.P.
Oil Consumption ....lbs. ....kilos. per hour at above H.P.
Propeller speed ..........R.P.M. at above engine speed.
Weight of engine ....lbs. ....kilos.

The weight of the engine includes the following parts:

1—Ignition (service magneto and wire supports or battery ignition distributor and coils and wire supports).
2—Generator (if used) with cut out, etc., and ammeter.
6—Carbureters.
7—Inlet pipes.

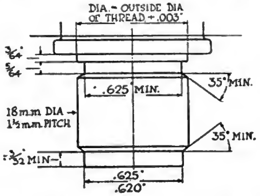
Above numbers refer to parts given in the schedule.

Comparison of standard water-cooled engines with rotaries and fixed air-cooled types may be made by means of above schedule of weight.

Spark Plug Shell

O. C. Rohde made the report for the spark plug shell subcommittee. Investigation seems to show that a 1-in. hex is nearest to foreign standard. Further information is being sought on the Italian standard. If a 1-in. hex proves to be approximately the foreign standard, it will be recommended for airplane plugs. If the 1-in. hex is not found to agree with the foreign standards, some size now in use, preferably 15/16 in., will be recommended for adoption. In case a 1-in. hex is adopted and 1.025 in. is found to represent foreign practice, a spark plug wrench with a minimum dimension of 1 1 32 in. is recommended.

Where threads are chased, a flange 3/64 in. thick and .003 in. larger in diameter than the outside thread diameter is recommended, the neck to be .625 in. diameter by 5/64 in. thick. Where threads are rolled they may be run to the shoulder.



It is recommended that 3/32 in. be the minimum dimension from the bottom of the thread chamfer to the bottom of the shell.

Safety Belts

No definite recommendations were made by the sub-committee on safety belts, but Mr. Hunsaker had procured a sample of English manufacture which was exhibited at the meeting. This consists of two pieces of elastic webbing about 7 in. wide laced at the back with cotton lacing and secured together in front by a buckle clasp. This was said to be satisfactory to the Army. The Navy was said to be using a somewhat different design. Capt. Chanvalon thought that the lacing might better be of rawhide and that he would prefer elastic webbing in the fastening straps. Mr. Riddell submitted a belt and safety catch as used by the Canadian air forces. It was suggested to submit Mr. Hunsaker's sample to the Navy and ask them whether it would not meet their requirements.

Wheel Rims and Wheels

A progress report was submitted by J. E. Hale recommending rims of .093 stock containing .010 to .020 per cent carbon.

Screws and Nuts

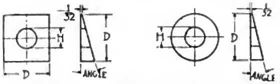
The report of the screw and nut sub-committees was submitted by E. H. Ehrman, and covered airplane bolt threads, fine threads, washers, etc. The recommendations follow:

S. A. E. AIRPLANE BOLT THREAD STANDARD

(All Threads to be of the U. S. Form)

Diameter	Threads per In.	Diameter	Threads per In.	Diameter	Threads per In.
No. 4 (.112)	36	No. 12 (.216)	32	7/16	20
No. 6 (.138)	32	¼	28	½	20
No. 8 (.164)	32	5/16	24	9/16	18
No. 10 (.190)	32	⅜	24	⅝	18

S. A. E. STANDARD BEVEL WASHERS



At left is shown square washer and on right, round washer

Values of angle are 6, 12, 24, 36 degrees for all sizes

Bolt Size	H	D
No. 4	No. 32 (.116)	⅜
No. 6	No. 27 (.144)	7/16
No. 8	No. 18 (.169)	15/32
No. 10	No. 10 (.193)	½
No. 12	No. 2 (.221)	9/16
¼	17/64	⅝
5/16	21/64	11/16
⅜	25/64	¾
7/16	29/64	13/16
½	33/64	1

S. A. E. AIRPLANE FINE THREAD STANDARD

(All Threads to be of the U. S. Form)

Diameter	Threads per In.	Diameter	Threads per In.	Diameter	Threads per In.
¼	40	1	20	3	16
5/16	36	1⅛	18	3¼	16
⅜	32	1¼	18	3½	16
7/16	28	1⅜	18	3¾	16
½	26	1½	18	4	16
9/16	24	1⅝	16	4¼	16
⅝	24	1¾	16	4½	16
11/16	22	1⅞	16	4¾	16
¾	22	2½	16	5	16
13/16	22	2¼	16	5¼	16
⅞	20	2½	16	5½	16
15/16	20	2¾	16	5¾	16
				6	16

S. A. E. AIRPLANE BOLTS

(Dimensions refer to drawing of bolts as adopted)

Size "A"	No. 4	No. 6	No. 8	No. 10	No. 12	¼
Threads per in.	36	32	32	32	32	28
Limits "A"	.108 112	.134 .138	.160 .164	.186 .190	.212 .216	.246 .250
Head Diam. "B."	¼	9/32	5/16	⅜	⅜	7/16
Head Height "M"	3/32	7/64	9/64	⅛	9/64	11/64

Size "A"	5/16	⅜	7/16	½
Threads per in.	24	24	20	20
Limits "A"	.308 .312	.371 .375	.433 .437	.496 .500
Head Diam. "B"	½	9/16	11/16	¾
Head Height "M"	3/16	7/32	¼	9/32

S. A. E. STANDARD BEVEL WASHERS

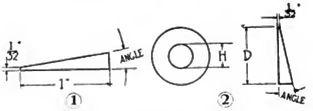
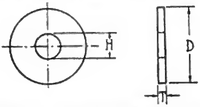


Figure 1 shows stock from which washers will be made
Figure 2 shows finished washer

Values of angle are 6, 12, 24, 36 degrees for all sizes

Bolt Size	H	D
No. 4	No. 32 (.116)	⅜
No. 6	No. 27 (.144)	7/16
No. 8	No. 18 (.169)	15/32
No. 10	No. 10 (.193)	½
No. 12	No. 2 (.221)	9/16
¼	17/64	⅝
5/16	21/64	11/16
⅜	25/64	¾
7/16	29/64	13/16
½	33/64	1

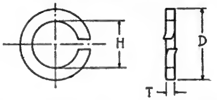
S. A. E. STANDARD PLAIN WASHERS



Bolt Size	H	D	T
No. 4 (.112)	No. 32 (.116)	⅜	.035 (No. 20 B. W. G.)
No. 6 (.138)	No. 27 (.144)	7/16	.035 (No. 20 B. W. G.)
No. 8 (.164)	No. 18 (.169)	15/32	.035 (No. 20 B. W. G.)
No. 10 (.190)	No. 10 (.193)	½	.035 (No. 20 B. W. G.)
No. 12 (.216)	No. 2 (.221)	9/16	.049 (No. 18 B. W. G.)
¼	17/64	⅝	.049 (No. 18 B. W. G.)
5/16	21/64	11/16	.049 (No. 18 B. W. G.)
⅜	25/64	¾	.049 (No. 18 B. W. G.)
7/16	29/64	13/16	1/16
½	33/64	1	1/16
9/16	37/64	1 1/16	1/16
⅝	41/64	1¼	1/16
11/16	45/64	1⅜	1/16
¾	49/64	1½	1/16
⅞	57/64	1¾	1/16
1	1 1/16	1⅞	1/16

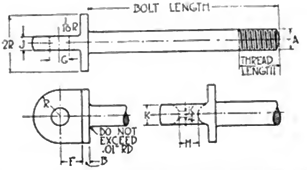
Numbers in "H" column are number size drills.

S. A. E. Standard Spring Washers



Bolt Size	Hole Clearance	H	Section	D
No. 4	[illegible]	.128	[illegible] x [illegible]	.190
No. 6	[illegible]	.154	[illegible] x [illegible]	.247
No. 8	[illegible]	.180	[illegible] x [illegible]	.305
No. 10	[illegible]	.206	[illegible] x [illegible]	.393
No. 12	[illegible]	.232	[illegible] x [illegible]	.482
¼	[illegible]	[illegible]	[illegible] x [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible] x [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible] x [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible] x [illegible]	[illegible]
½	[illegible]	[illegible]	[illegible] x [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible] x [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible] x [illegible]	1 [illegible]
[illegible]	[illegible]	[illegible]	[illegible] x [illegible]	1 [illegible]
[illegible]	[illegible]	[illegible]	[illegible] x [illegible]	1 [illegible]
⅞	[illegible]	[illegible]	[illegible] x [illegible]	1 [illegible]
1	[illegible]	1 [illegible]	[illegible] x [illegible]	1 [illegible]

S. A. E. Standard Airplane Eye Bolts



Bolt lengths and thread lengths same as S. A. E. Standard Hex. Head Bolts

Bolt end shown is to be used only when taking wires or cables directly

S.A.E. Nos.	Strength in Pounds	Diam. "A"	Hole Size "G"	Hole Size "H"	Dimension "R"	Dimension "F"	Dimension "B"	Dimension "J"	Dimension "K"
1	500	No. 12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	1000	No. 12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	1500	No. 12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	2000	¼	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	2500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	3000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	3500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	4000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	4500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	5000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11	6000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	7000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	8000	½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	9000	½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	10000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Tests on Glue

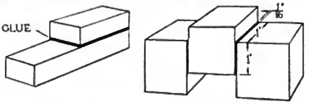
A subcommittee on glues made a report containing specifications for all glue used for propeller construction and for splices of important structural members such as longerons and beams.

The glue must be a high-grade hide glue, sweet and free from any deleterious substances. The glue shall be compared to a standard sample for adhesiveness, jelly strength, viscosity, grease and foam. The standard sample may be obtained from the director of the Forest Products Laboratory, Madison, Wis., or may be a sample of a glue which has been satisfactorily used in propeller construction and certified to by the authorized glue expert of the purchaser.

Tests on glue shall include tests made at the glue factory and tests made at the airplane factory. Tests at the glue factory are to insure a proper quality and certification of this quality. These tests shall be made by comparing the run of glue with the standard sample.

The bidder may compare his glue with the standard sample by any methods he desires. The tests by the purchaser, however, will be made as follows:

The strength test will be made by gluing together two pieces of yellow birch 1 in. thick, having a shearing strength of at least 2200 lb. per square inch. This will require birch having an air-dry weight of about 50 lb. or more per cubic foot, and a moisture content of from 8 to 12 per cent. These should be tested by shearing them in a testing machine. The glue will be mixed in proportion recommended by the glue manufacturer. It will then be melted in a water bath and applied to the wood at a temperature of about 60 deg. C. (140 deg. F.). After gluing the test blocks will be held in clamps for 24 hr., then removed from the clamps and allowed to stand for six additional days. They will then be finished so that the blocks when ready to test will have a glued joint 2 in. square and will be of the shape shown in the sketch. When tested in this way no test block shall fail under a load of less than 2200 lb. per square inch.



Test Pieces Referred to in Glue Report

The jelly strength will be determined upon a mixture containing 12 parts of water to 1 part of glue. The glue will be soaked and melted as described under "Adhesiveness," then allowed to stand over night in a refrigerator at a temperature of 5 to 10 deg. C. (40 to 50 deg. F.). The relative strength of the standard sample, and the bidder's sample will then be determined by pressure with the fingers immediately after the samples are removed from the refrigerator.

VISCOSITY TEST

The viscosity will be determined in an Engler viscosimeter upon a sample containing 1 part of glue to 5 parts of water, soaked and melted as described under "Adhesiveness." Two hundred cubic centimeters of the glue mixture will be run through the viscosimeter at a temperature of 60 deg. C. (140 deg. F.).

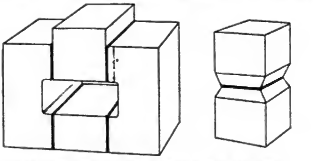
The relative amount of grease present will be determined by mixing dye with some of the sample remaining from the viscosity test, painting it on unsized white paper and observing the grease spots.

The foam will be tested on the sample used for viscosity. The sample heated to 60 deg. C. will be beaten for one minute with a power egg beater or similar instrument, and allowed to stand one minute, or until the height of foam can be measured.

The odor of the glue when in the hot solution must be sweet and must remain sweet for 48 hr.; that is, free from any suggestion of deteriorating animal matter.

TESTS AT AIRPLANE FACTORY

Tests made at the airplane factory are to determine the strength of the glue joints under the average conditions prevailing in the glue room. Tests shall be made on representative woods used by the manufacturer concerned. The glue test specimen shall be made of three boards ¾ in. to 1 in. thick, 4 ft. long and 5½ in. wide. The gluing must represent actual practice, and no special precautions other than those ordinarily used shall be taken in preparing the glue or wood for the test specimen. The gluing shall be performed by the employes of the airplane factory who are accustomed to



Shear and Tension Specimens for Glue Tests handling this kind of work. No protective coating of any kind shall be applied to the wood surface or to the finished specimen. The specimen shall set not longer than one week. The 4-ft. specimen shall be cut lengthwise and 10 shear blocks cut from each half according to the dimensions given on sketch. The shear blocks shall be tested as follows:

(a) Ten of the shear blocks shall be tested immediately after sawing. The strength of the glue in shear shall not be less than that of the wood.

(b) Ten of the shear blocks shall be soaked in water at 20 deg. C. for 15 hr. and tested within 30 min. after removal from the water, without any preliminary drying. The strength after soaking shall not decrease more than 60 per cent.

The required strength shall be obtained for 80 per cent of the samples tested under each condition. A rejected propeller may be substituted for the 4-ft. specimen specified above.

The tests at the glue factory shall be made by or under the personal supervision of a glue expert authorized by the purchaser to make such test. The tests shall be made on every run of glue which is to be used in airplane construction.

The tests at the airplane factory shall be in the presence of an inspector for the purchaser regularly stationed at the factory and familiar with the methods employed there. A test shall be made whenever a brand of glue is changed or a change is made in the method of gluing, which, in the opinion of the purchaser's inspector, is important enough to warrant a test.

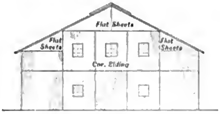
The glue which has been tested at the glue factory shall be barreled in the presence of the purchaser's representative and marked with the run number, rate of run, and inspector's stamp. The glue which is marked in this manner may be sold as certified glue for airplane construction.

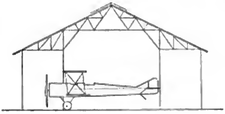
Portable Standardized Steel Hangars

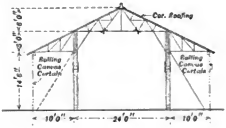
In the construction of hangars standardization is an important factor when expansion may become necessary. A standard product is not only more economical to turn out but additional sections such as are often required can be added with a minimum of expense and trouble. It is moreover a simple matter to make a standard structure portable and fireproof if it be of steel construction.

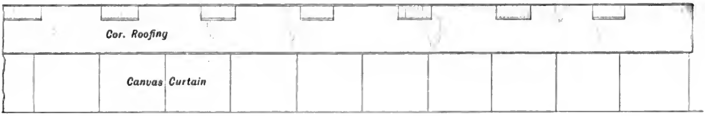
It is claimed that one of these three plane hangar may be erected, taken down, moved to a new location and put up again in three weeks by six men, and that the time can be shortened by using additional help. Skilled mechanics are not required for this work.

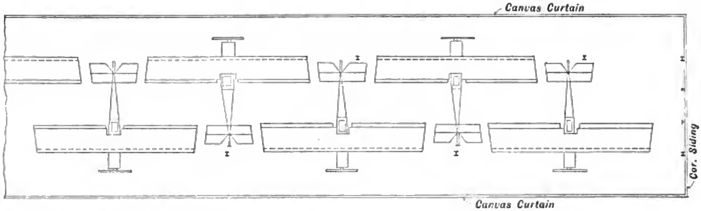
One advantage of a standardized hangar is that additional units as desired may be added to a structure at any time.











The diagrams shown herewith illustrate one of the standardized designs of portable hangars that are manufactured by the Steel Fabricating Co. This type of building is composed of any desired number of sections 56 ft. long and 44 ft. wide, or 48 ft. long and 44 ft. wide. The doors are on both sides of the structure.

The roofs and side walls of each design are made in 8 ft. sections and all parts are standardized. While primarily designed for permanent structures, both types are portable with the exception of the cement floor, which is laid when desired.

While the diagrams show that curtains are used, standardized accordion or folding steel doors may be substituted. The openings of the doors in the hangar illustrated are 56 ft. wide by 14 ft. 6 in. high, which is sufficiently large to admit most planes now being manufactured.

The height of the units in the 56 x 44 ft. and the 48 x 44 ft. types is 14 ft. 6 in. in the clear underneath the lowest portion of the roof trusses. These hangars are arranged with two rows of columns located as shown in the plan and which support the longitudinal and transverse trusses.

Digest of the Foreign Aeronautical Press

Flying (London), September 12, 1917

On an Aeronautical Library.—The paucity of really good books on aeronautics is somewhat remarkable at first to the outsider, who has got beyond the elementary error of supposing that the history of aeronautics started a few years ago only. He is apt to go to the other extreme and expect to find the subject exhaustively treated long before it became a practical proposition, rather like electricity was, in its modern applications.

In point of fact, although certain outstanding treatises give many of the salient points, to gain a true perspective of the science of flight in its present status demands a lengthy study of many and various volumes by many and various writers—all containing something of value and most containing much chaff as well.

In the *Bibliography of Aeronautics*, published by the Smithsonian Institution in 1910, and taking in all publications up to 1909 dealing with aeronautics, there are 13,500 titles. It is not proposed to set this collection out at length here, and the making of a selection is in some ways a very invidious task. But let us assume that someone is just taking up the study of aeronautics, not from any particular point of view, but just broadly.

What books ought he to read? In the writer's opinion the following should not be missed:

Langley Memoir on Mechanical Flight, by Langley and Manly.
Aerial Navigation, by Sir Geo. Cayley.
Aerial Locomotion, by F. H. Wenham.
Gliding, by Percy Pilcher.
The Flight of Birds, by G. A. Borelli.
L'Empire de l'Air, by L. P. Mouillard.
Airships, Past and Present, by A. Hildebrandt.
Aircraft in Warfare, by F. W. Lanchester.
The Aeroplane, by A. Fage.
Bird Flight as the Basis of Aviation, by O. Lilienthal.
Design of Aeroplanes, by A. W. Judge.
The Mechanics of the Aeroplane, by Captain Duchêne.
Pocket Book of Aeronautics, by H. W. L. Moedebeck.
Airscrews, by M. A. S. Riach.
Nouvelles Recherches sur la Résistance de l'Air et l'Aviation, by G. Eiffel.
Stability in Aviation, by G. H. Bryan.
Artificial and Natural Flight, by H. Maxim.
Aerodynamics and Aerodonetics, by F. W. Lanchester.
The Properties of Aerofoils, by A. W. Judge.
Aero-Engines, by G. A. Burls.
High Speed Internal Combustion Engines, by A. W. Judge.
The Aero-Engine, by Kean.
The Aeroplane Speaks, by H. Barber.
Animal Flight, by Hankin.
Le Vol des Oiseaux, by Marey.

Flight (London), September 20, 1917

Air Raids and Some Conclusions.—First, let us deal with air raids against the two capitals. If we presume that the German raiders start their flight from some point in Belgium, Bruges for instance, the distance to London, taking a direct route, is only about 140 miles, 100 of which are over the sea. From the time when the raiders cross the English coast to the time when they arrive over London only about half an hour elapses, which leaves little time for giving warning and sending airplanes up in pursuit, although it is true a somewhat longer warning of their approach should be available through our organized system of defense.

On the other hand, the distance from a point on the French front, as Verdun or Nancy, for instance, to Berlin is in the neighborhood of 430 miles, giving a total distance to be covered of 860 miles. This is in itself a serious problem to solve from a technical point of view, quite apart from the fact that it is to be expected that every mile of those 860 will, figuratively speaking, be contested by the enemy's anti-aircraft defenses. Opinions as to the possibility of making the round trip are probably divided.

As for ourselves, we have for some time been firmly convinced that it can be done, and we feel quite confident that it will be done. We are keenly aware of the difficulties and do not underestimate these, but it is now already many months since a French pilot flew to Berlin and thence to within a few miles of the Russian front. It is true that this pilot did not drop anything more frightful than pamphlets on Berlin, but so rapid is the development in aviation that today there are undoubtedly in existence machines capable, with comparative safety, of the round trip of 860 miles. That we are justified in this assumption appears to be confirmed by the report published last week of the Italian aviator, Capt. Giulio Laureati, covering a distance of approximately 1,000 miles on a new Italian airplane. The possibilities opened up by this splendid flight are enormous.

Berlin may now be said to be within bombing distance of either the French or Italian fronts, and if the Huns persist, the day should not be far distant when bombs instead of pamphlets are showered on Wilhelmsstrasse. If Berlin were the only objective to be aimed at, the time for warning would necessarily be so long as to enable the enemy to make all his preparations beforehand and be ready for our bombers long before they got to Berlin. Since, however, large portions of Germany are within the 500 miles radius—in fact, all of Germany except East Prussia—there are a number of points where attacks from the air could be made with advantage.

BRITISH NAVAL SEAPLANE
Photo Underwood & Underwood

Thus we have, in Germany, the industrial centers of Westphalia and Krupp works at Essen, for instance, the shipping port of Hamburg, the fortifications and shipyards all up and down the German North Sea coast, not to mention the Kiel Canal itself. In the south there are such places as Stuttgart and Frankfort, in times of peace centers for the motor industry, but now undoubtedly busily engaged on war work. In Saxony there are the chemical factories at Chemnitz, Leipzig and Freiberg. If we are minded to revenge Louvain, Rheims, etc., there are such ancient art cities as Munich, or the mediaeval town of Nuremberg.

As for Austro-Hungary, all the portions that are of any industrial or military importance are within reach of aircraft from the Italian frontier. The two capitals, Vienna and Budapest, are situated at a distance of only approximately half of the 500 miles radius, and therefore could, and we think, should, be given a taste of their own pet form of frightfulness. The industrial centers of Austria are not so very far from the Italian front, being chiefly spread around the eastern slope of the Alps and in the country between the Alps and the right bank of the Danube. In Bohemia we have the Skoda works at Pilsen, which are, of course, the Krupps of Austria. Again, in Austro-Hungary the Governments have spent millions of pounds on the canalization of the rivers, which have been rendered navigable to an astonishing extent.

Airisms from the Four Winds.—In referring to the aeronautical part of the United States war activities, Lord Northcliffe sums up as follows:

"The enthusiastic outpourings of air amateurs and their cries of 100,000 airplanes have made a good many people sceptical as to American participation in the air fighting. But behind all that talk is **already a vast accomplishment.** The solid foundation has been laid of an air service, backed by practically illimitable man-power and machine-power. Its fruits will be shown as suddenly as came conscription. The movement is going on as rapidly as possible, having regard to the thoroughness with which everything is being done. There has been a complete liaison with the air services of France and England. The models of the latest French and English machines are here. While no time has been lost, most careful consideration has been given to a definite plan of campaign."

TWO BRITISH AIRSHIPS

(C) Underwood & Underwood *British Official Photo*

Captain Ball's Victor.—That Captain Ball, V.C., R.F.C., was not killed by the German crack aviator Baron von Richthofen, but by his younger brother, is asserted by the former in his book, "The Red Battle Flyer," in which Captain Ball's death is described as follows:

"My brother's twenty-second adversary was the famous Captain Ball, by far the best English flying man. The equally well known Major Hawker I had already taken to my bosom some months earlier. It gave me special joy that it should be my brother's luck to down the second of England's champions.

"Captain Ball was flying a triplane, and encountered my brother alone at the front. Each one tried to grip the other, and neither exposed any vulnerable part. It proved a brief encounter. Neither of the two succeeded in getting behind the other.

"Suddenly within the brief moment of mutual frontal attack both managed to fire some well-aimed shots. Both flew at one another; both fired. Each had an engine before him, and the chances of a hit were very slender, the speed being double as great as the normal. There was really little probability of either hitting the other.

"My brother, who was somewhat lower, had banked his machine too much and he lost his balance. For a few moments his machine was beyond control. Very soon, however, he regained command, but found that his opponent had shot both his petrol tanks to pieces. To land was, therefore, the only resource.

"Quickly! Out with the plug, or the body will burn! The next thought was: What was to become of my opponent? At the moment of canting he had observed how the enemy also had swerved aside. He could, therefore, not be very far from him. The question arose: Is he over or under me? He was below. My brother saw the triplane swerving again and falling ever more deeply. Captain Ball fell and fell until he reached the ground. He was on our territory.

"Both adversaries had in the brief moment of their encounter hit each other with their powerful machine guns, and Captain Ball had received a shot in his head. He had on him some photographs and newspaper cuttings from his home country, in which he was greatly praised. He appeared shortly before to have been home on leave.

"During Boelcke's time Captain Ball had destroyed thirty-six German machines. Now he, too, had met his master—or was it a coincidence that a great one such as he should also die the usual hero's death? Captain Ball was without doubt the leader of the anti-Richthofen squadron, and I believe that now the Englishmen will prefer to abstain from trying to catch me. I am sorry for this, because thereby we are robbed of many a fine opportunity for giving the English a jolly drubbing. Had not my brother been wounded, I believe he would on my return from leave also have been granted his leave with fifty-two Englishmen to his credit."

Espana Automovil (Madrid), August 30, 1917

On Aerial Warfare.—The Germans are employing the Zeppelin type of airships for two purposes, namely, naval reconnaissance in conjunction with fleet actions and for offensive operations, the latter chiefly against the British Isles. While highly efficient in the pursuit of the first named object, the Zeppelin has proved much less satisfactory in bombing raids.

For offensive operations the Germans use the gigantic super-Zeppelin type of 56,000 cu. m. volume, which has an outer cover of silk, a speed of sixty-two miles per hour and carries four quick-firing guns, ten machine guns and four tons of explosives.

Better results appear, however, to have been attained with a smaller scouting type of Zeppelin which has a volume of only 30,000 cu. m., a speed of fifty-six miles per hour, and carries two quick-firing guns, six machine guns and two tons of explosives.

(The quick-firing guns mentioned may refer to the automatic guns of ½ in. bore of which three were found to be mounted on the *L33*, a Zeppelin which was brought down in England last fall by British aviators.—EDITOR.)

Flying (London), September 5, 1917

The Handicap of the Wind.—The *Times* correspondent on the Western front confirm Mr. Lanchester's views as to the handicap of the westerly winds. He says that "fighting nearly always drifts over the enemy's territory and that the Germans habitually endeavor to draw our men farther over their own ground, where even a small mishap may prevent them, against the adverse winds, to regain their own lines."

The handicap of the wind also deprives Allied pilots of the necessary evidence as to crashed German machines, without which their claim to victory is not officially recognized. All claims are carefully scrutinized at some three stages before they are finally admitted and published by the High Command. Probably in one-third of the cases where the pilots get credit for having crashed enemy machines, the claim is allowed only through the accident of some other aviator, flying low at the time, having seen the descent from the clouds above and the actual collision with the earth, or some similar corroborating evidence.

Aero-Engine Induction.—With the Gnome Monosoupape engine the gasoline feed system to the carburetor may be by gravity or air pressure, by a mechanical driven air pump supplying air to the main tank, or the carburetor may be supplied under pressure by a mechanically driven gasoline pump actuated by the engine.

When the first system is used the fuel flows direct from the tank to the connection on the crankshaft and the gasoline tank must be a certain height above the center line of the engine in order to provide the necessary head. The air pressure system of fuel supply allows the tank to be placed in any convenient position and the gasoline is supplied to the jet at constant pressure. A hand-operated air pump is fitted for obtaining the initial pressure in the tank and the air pump driven from the engine maintains this pressure when the engine is running. An adjustable automatic relief valve is used and this can be regulated to give a constant pressure of air in the tank; also it may be adjustable during flight to correct the pressure to compensate for any difference in the atmospheric pressure due to altitude.

In cases where the gasoline tank is placed above the center line of the engine, the latter can be started by allowing sufficient gasoline to flow into the crankcase by gravity, but for any other position of the tank a small auxiliary hand pump is required and connected in parallel with the mechanical pump piping. One or two strokes of this hand pump is all that is required for priming the engine sufficiently for starting.

News of the Fortnight

George O. Squier Made Major-General

Brig. Gen. George O. Squier, Chief Signal Officer, U. S. A., was promoted on Oct. 5 to be a major-general.

General Squier was born in Dryden, Mich., on March 21, 1865. He graduated from West Point in 1887 and was made a second-lieutenant in the Third Artillery. He became a first-lieutenant on June 30, 1893, and was commissioned a signal officer with the rank of captain of volunteers on May 20, 1898. After having served through the war with Spain, he was honorably discharged as an officer of volunteers on June 30, 1901, having previously been appointed a captain in the Signal Corps, U. S. A., on Feb. 2, 1901. He became a major on March 2, 1903, a lieutenant-colonel on March 17, 1913, and a brigadier-general on Feb. 14, 1917.

Maj.-Gen. George O. Squier, U. S. A.

General Squier's interest in aeronautics dates a long way back. When a major he drew up the specifications for the first American military airplane, as the result of which the United States Army acquired in 1908 a Wright biplane, thus being the first army to be equipped with aviation *matériel*. To his efforts was likewise due the purchase, by the Signal Corps, of a small training airship built by Capt. Thomas S. Baldwin.

General Squier was for four years military attaché at the American Embassy in London. Two of these years were years of war. He thus had an excellent opportunity to study the extraordinary increase the war brought about in Great Britain's aerial establishment as well as the technical specialization of the respective *matériel* and the special training of the personnel. Therefore, when the United States decided upon the creation of an air fleet, the choice of the authorities could not but logically fall upon General Squier who, after having headed the now greatly expanded Aviation Section of the Signal Corps, became, in view of his excellent services, Chief Signal Officer. General Squier's last promotion only confirms the high esteem in which this savant officer is held in Washington.

General Squier is a member of the Royal Institution of Great Britain, to which he was elected in recognition of his work in perfecting sine-wave telegraphy whereby the efficiency of submarine cables was increased from 50 to 100 per cent.

Patent Pooling Agreement Upheld

Attorney-General Gregory has ruled that the patent pooling scheme in the agreement between the Aircraft Production Board and the Manufacturers' Aircraft Association, intended to prevent patent litigation, does not violate the Sherman anti-trust law.

This ruling clears away a possibly serious obstacle in the path of the aircraft program of the Government. The effect of the opinion is to ratify all the work done by the Aircraft Production Board and the Advisory Committee for Aeronautics, and insures the employment of the entire airplane producing capacity of the country on the big task.

In general terms, the agreement provides for the pooling in the Manufacturers' Aircraft Association of the basic airplane patents known as the Wright and Curtiss patents, and also of all other airplane patents now held or hereafter developed by members of the Association. The organization is open to any builder or patentee on payment of nominal association fees.

Provision is made for royalty payments at $200 a machine, a reduction to about one-fifth of the sum asked by patent holders before the scheme was worked out. With the exception of $25 assigned to maintain the Association, the royalty goes to holders of controlling patents. A maximum limit of $2,000,000 is fixed, however, for each of the Wright and Curtiss claims. Holders of any future controlling patents who are members of the Association will share in royalties as later determined.

Proposed Aeronautical Show

The Second Pan-American Aeronautic Exposition is being advertised to be held at the Grand Central Palace, New York City, Feb. 16 to 23, notwithstanding that the Aircraft Production Board recently passed the following resolution in regard to holding an aeronautical exposition during the war:

"*RESOLVED*, that as a matter of general policy, in view of the military situation, the Board does not encourage the holding of any expositions of aircraft for the duration of the war; that for military reasons no developments of new types of engines or planes can be exhibited, and the inevitable distraction of interest on the part of the manufacturers will not be in the interests of the military departments."

There has been no change in the policy of the Government in regard to holding an exposition this year, and the above resolution is still in force.

The Manufacturers' Aircraft Association has, it is stated, given no encouragement to the holding of an exposition this year, in view of the war and the Government's expressed wishes in the matter. If other conditions prevailed under which an aeronautical show would be desirable this year, it is understood that the policy of the Manufacturers' Aircraft Association would be to conduct the show under their own auspices.

National Advisory Committee Election

At the annual meeting of the National Advisory Committee for Aeronautics held recently Dr. W. F. Durand was reelected chairman and Dr. S. W. Stratton was reelected secretary. Members of the executive committee were elected as follows: Dr. Joseph S. Ames, Dr. Charles F. Marvin, Dr. Michael I. Pupin, Maj. Gen. George O. Squier, United States Army, Dr. S. W. Stratton, Rear Admiral D. W. Taylor, United States Navy, and Dr. Charles D. Walcott.

At the organization meeting of the executive committee Dr. Charles D. Walcott was elected chairman and Dr. S. W. Stratton, secretary. Existing subcommittees were continued, and an editorial committee was appointed to prepare for publication the technical reports.

Aviation Section Now in New Home

During the past week the various branches of the Aviation Section, Signal Corps, with the exception of the Photographic Division, that were located in the Mills Building, Washington, D. C., moved into the old Southern Railway Building on D Street, N. E., near the Union Station.

Maj.-Gen. Goethals Heads Wright-Martin

On Oct. 3 Maj.-Gen. George W. Goethals was elected president of the Wright-Martin Aircraft Corp. He will take at once an active part in directing the corporation's affairs in an advisory capacity.

Since his retirement as general manager of the Shipping Board, General Goethals has been engaged chiefly in undertakings of his engineering firm, Goethals, Jamieson, Houston & Jay, 40 Wall Street, New York.

General Goethals's election as a Director of the Wright-Martin Corp. occurred at the annual meeting of shareholders.

Maj.-Gen. George W. Goethals
(C) Underwood & Underwood

When the other directors decided to make him president, he accepted with this statement:

"I have seriously considered and discussed my acceptance of the position to which you have elected me, and I have accepted it with the view of doing some work that will be useful and assist in the prosecution of the war. My acceptance is from a sense of duty, and for such time as I can be helpful, or during the war period."

George H. Houston, a partner of General Goethals, is to continue as vice-president and general manager of the Wright-Martin Corp. Marshall J. Dodge, of Bertron, Griscom & Co., was elected a director and the retiring members were re-elected for another year.

The Wright-Martin Corp. recently obtained a large order from the Government for Hispano-Suiza airplane engines. The output of the Wright-Martin plant at New Brunswick, N. J., is to supplement the Government's production of Liberty engines to equip the airplanes now in process of construction. The company a year ago engaged to build 450 Hispano-Suiza engines, in part for the French Government, and is still at work upon them.

The annual statement says that as soon as the last of the engines shall be completed, which will be in a few weeks, the full plant capacity is to be devoted to United States Government work.

General Goethals' achievement as the builder of the Panama Canal is known and recognized throughout the civilized world. He was appointed a member of the Isthmian Canal Commission March 4, 1907, by President Roosevelt. He arrived on the Isthmus March 12 following, and on April 1 the President placed him in complete charge of the work as Chief Engineer and Chairman of the Isthmian Canal Commission.

From that date the dirt began to fly. Completing the work ahead of schedule and for several millions dollars under the estimate of $375,000,000, on April 1, 1914, the old construction organization went out of existence and General Goethals was made the first Governor of the Panama Canal Zone.

Although General Goethals is a great engineer, it is recognized that his achievement at Panama was mainly due to his wonderful executive and administrative ability in creating and speeding up an organization which at its zenith numbered nearly 50,000 men. The *esprit de corps* which he inspired in the workers and their determination to put the job over was merely a reflection of the General's own personality.

Goethal's administration was known as a benevolent autocracy, with underlying justice for officials or laborers. His Sunday morning "court" was one of the institutions of the Isthmus, where he personally heard the disgruntled laborer or high official, settled personal and even family differences, administered discipline, heard suggestions for betterments and meted out justice to all.

And these Sunday mornings throughout his administration were at the expense of the rest and recreation of a man who was considered the hardest worker on the canal.

Impatient of the inefficiency of divided control and responsibility where a big job is to be accomplished, the General's opinion that "Boards are long, narrow and wooden" is an excellent indice to a big, kindly, and brilliant soldier, engineer and administrator.

Maj.-Gen. Goethals received his training as an officer in the Engineer Corps of the United States Army. He was born in Brooklyn, N. Y., June 29, 1858. He was graduated from West Point in 1880, being commissioned a Second-Lieutenant of Engineers June 12, 1880. His first lieutenancy came in 1882, and he was promoted to captain Dec. 14, 1891. During the Spanish-American War he served as Chief of Engineers in the volunteer army, with the rank of lieutenant-colonel.

He was promoted to his majority in the Engineer Corps Feb. 7, 1900; March 2, 1907, to lieutenant-colonel, and Dec. 3, 1909, to colonel.

By special Act of Congress, Colonel Goethals, in recognition of his exceptional services on the Panama Canal, was advanced to the rank of major-general March 4, 1915.

The Signal Corps Wants Lenses

The Chief Signal Officer requests that the widest publicity possible be given the following appeal:

People of the United States are asked to help the Signal Corps of the Army get lenses enough for cameras for the fleet of observation airplanes now being built. The need is immediate and of great importance; the airplanes are the eyes of the army and the camera lenses are the pupils of those eyes.

German lenses can no longer be bought in the open market. England met this difficulty, in the earlier stages of the war, by requiring lens owners to register lenses and requisitioning those needed. England is now making lenses better than the German ones formerly imported but no faster than needed for her own uses. The Bureau of Standards of the United States Department of Commerce is now perfecting a substitute for the German "crown barium" glass used for lenses and will later be able to meet the needs, and special lenses are being designed for this work.

The situation now, however, is that, with airplanes soon to be ready for service, suitable lenses cannot be bought. Hundreds are needed at once. Possessors of the required types are urged to enlist their lenses in the Army. They are asked immediately to notify the Photographic Division of the Signal Corps, U. S. A., Mills Building Annex, Washington, D. C., of lenses of the following descriptions which they are willing to sell, stating price asked:

Tessar Anastigmat Lenses, made by Carl Zeiss, Jena, of a working aperture of F. 3.5 or F. 4.5, from 8¼ to 20 in. focal length.

Bausch & Lomb Zeiss Tessars, F. 4.5, from 8¼ to 20 in. focal length.

Voigtlander Heliar Anastigmat Lenses, F. 4.5, 8¼ to 24 in. focal length.

Practically all of the lenses of these types in America will be required, but the 8¼ in. lenses are most urgently needed.

MY SOLDIER

"A boy," said the kindly old doctor, as he felt his way down the stair-rail. He put his arm around the shoulder of the man he met at the bottom, and they stood there listening. A small cry carried down to them, so that tears glistened in the man's eyes as he bade the old doctor good-night.

"A smart boy," said the teacher, when he got his lessons well.

"A wonderful boy," said the maiden, who worshipped him from afar.

"My boy," said his Country, when the call came—To War!

"Our boy," said his mother and father, as they proudly watched him march away to take his part in the Great Struggle for Freedom and Humanity.

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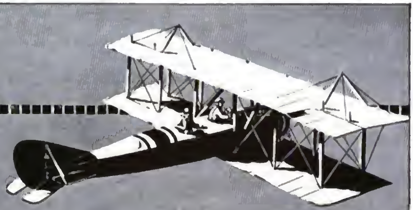

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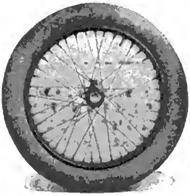

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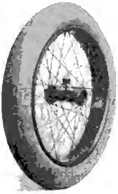

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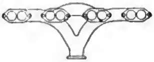

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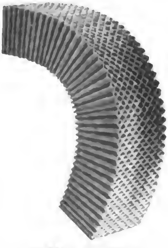

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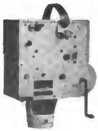

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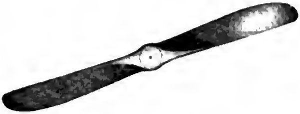

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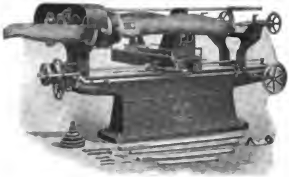

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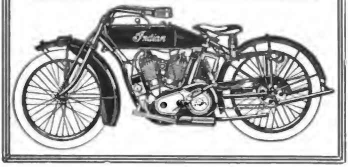

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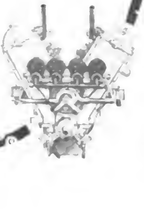

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State of New York }
County of New York } ss.

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared George Newbold, who, having been duly sworn according to law, deposes and says that he is the Business Manager of Aviation and Aeronautical Engineering and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912 embodied in section 443, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

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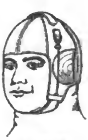

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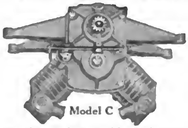

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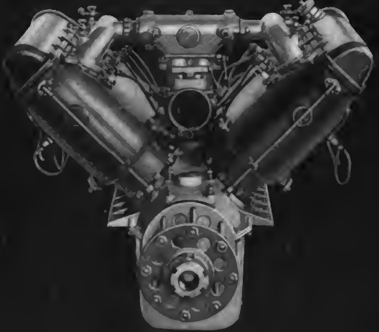

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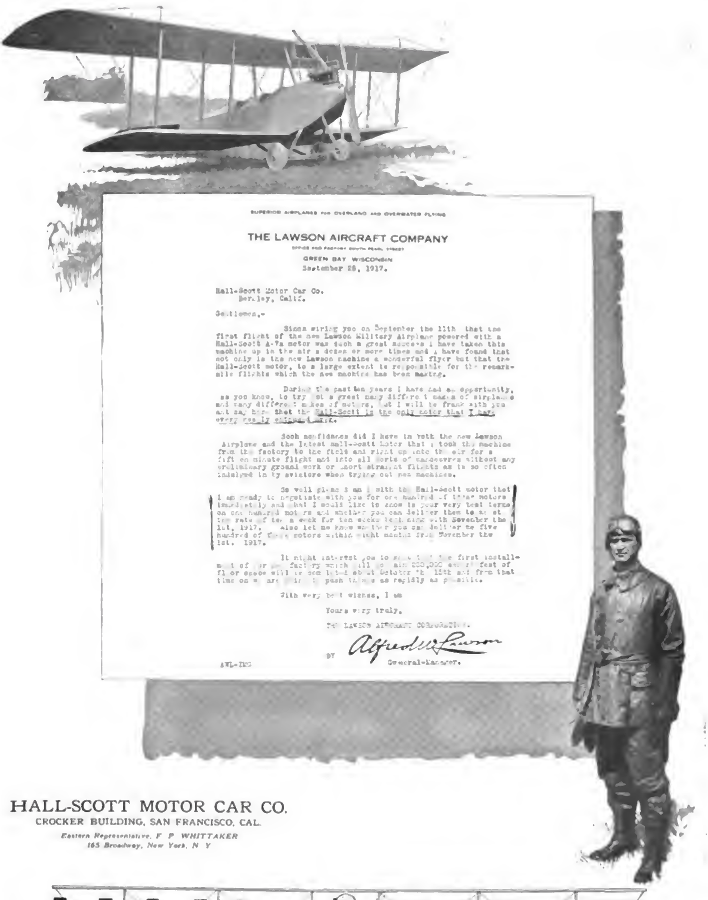

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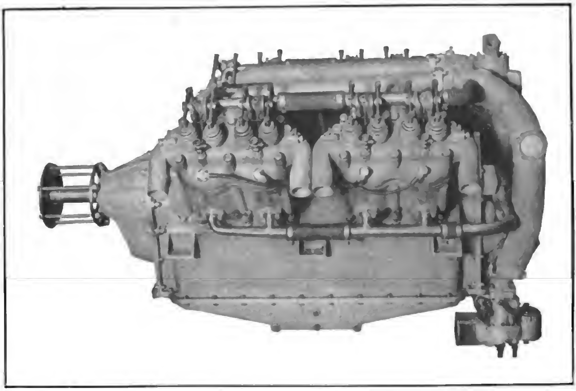

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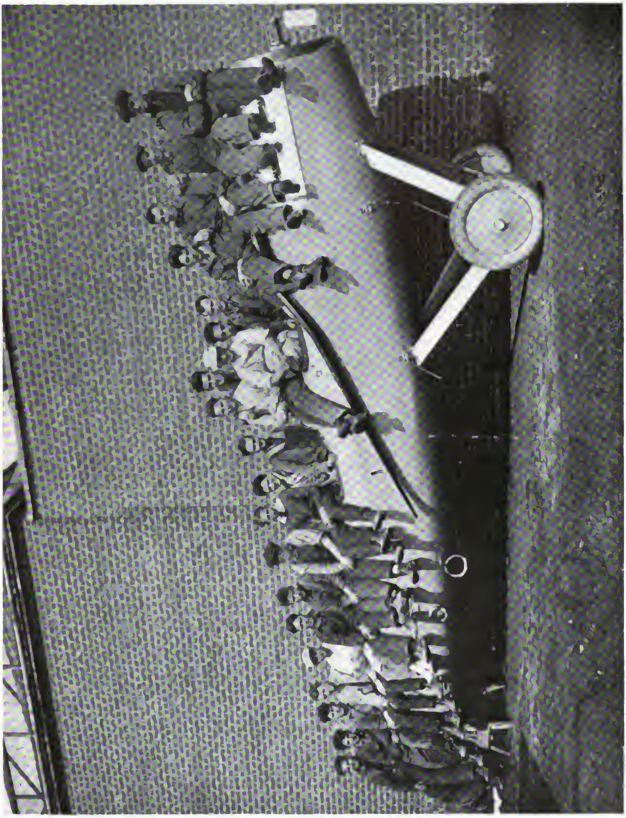

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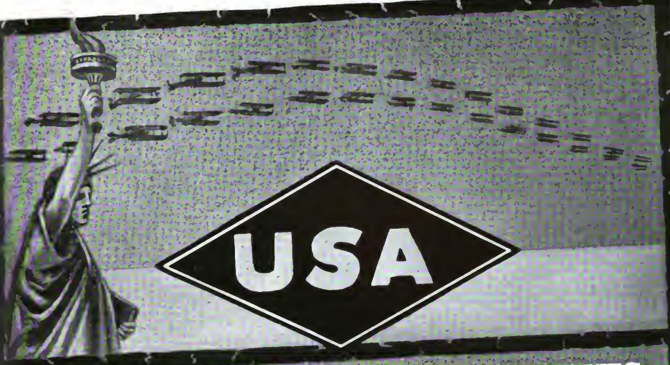

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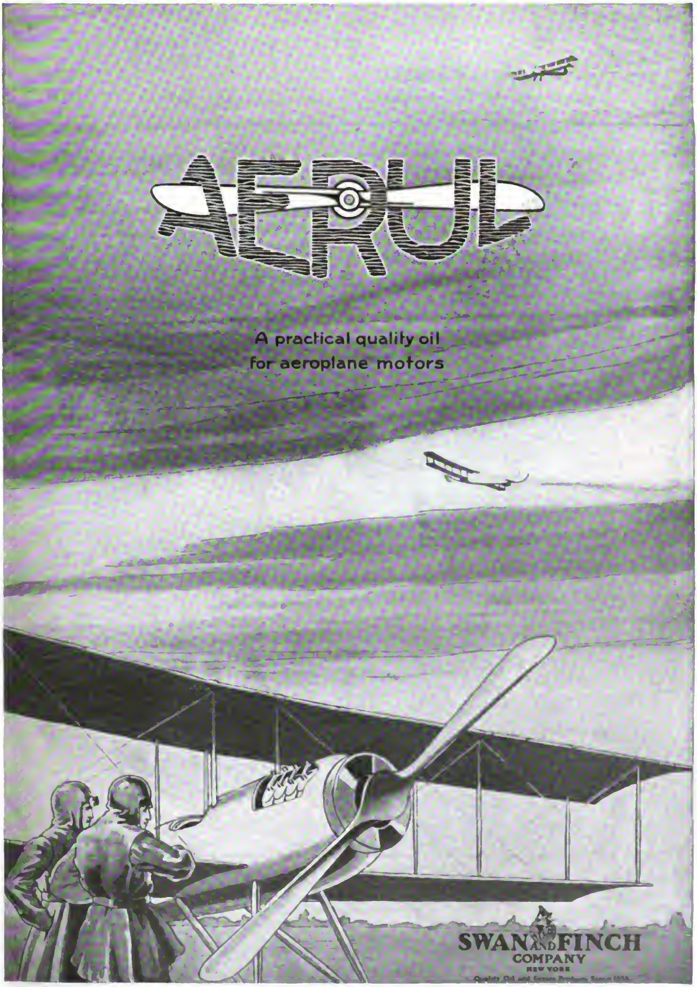
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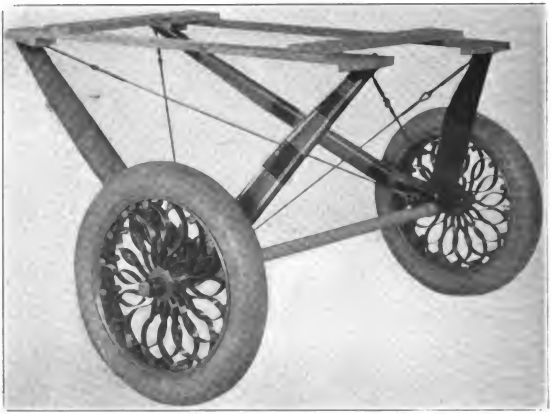

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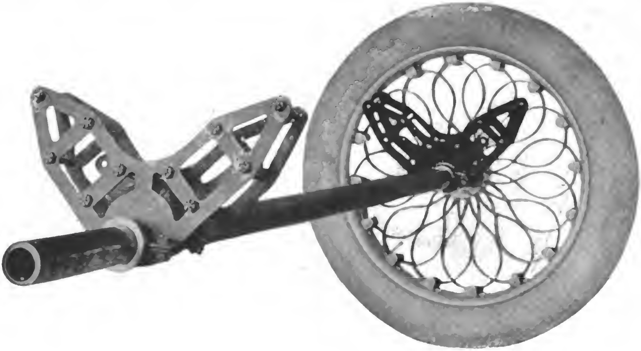

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Whirling Table and Method of Testing Model Airscrews at N. P. L.

By A. Fage, A.R.C.Sc., D.I.C.

At the present time there are two different methods of testing airscrews at the National Physical Laboratory, (*a*) with an airscrew dynamometer mounted on a whirling table and, (*b*) with an airscrew balance designed for use in a wind channel.

The present article deals only with the first of these methods, but the author hopes to obtain permission to publish, in the near future, a description of the airscrew balance.

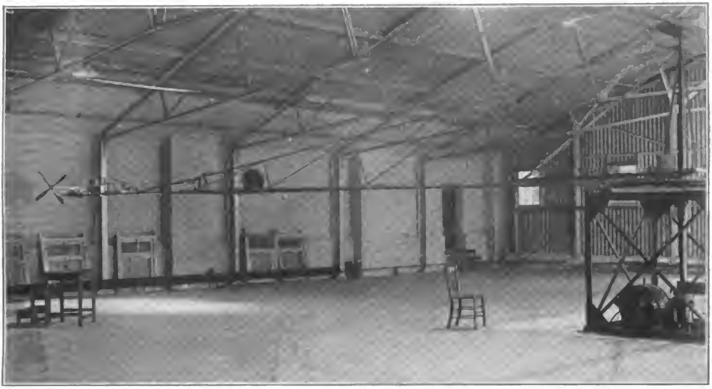

Fig. 1. Whirling Table at the N. P. L.

Description of the Whirling Table and the Airscrew Dynamometer

A brief description of the whirling table as first designed is given in the "Technical Report of the Advisory Committee for Aeronautics, Year 1909-10," but since that time both the dynamometer and the method of experimenting have been considerably modified and improved.*

The whirling table, a photograph of which is given in Fig. 1, is housed in a galvanized iron shed, 80 ft. by 80 ft., so that the airscrew experiments may be carried on independently of the atmospheric conditions. The over-all diameter of the whirling table is 60 ft., the dynamometer being carried at the end of an arm of length 30 ft., which is built up of light steel tubes tapering from 1½ in. diameter at the axis to 1 in. diameter at the extremity. These tubes are spaced 12½ in. apart and are connected together by struts. The central post of the whirling table is carried up from the floor to the roof, the arm being stiffened by connecting the tubes to a cantilever built up of light angle iron and provided with cross bars and steel wire ties. The whirling table is driven by a 14 hp. electric motor, through a worm reduction gear of 28 to 1.

To avoid straining the central post by the inertia of the arm when the motor is stopped, the post is cut immediately above the worm wheel and the upper and lower parts connected by a ratchet gear which allows the free rotation of the arm.

The speed of rotation of the whirling table, which is regulated by an adjustable resistance in the armature circuit of the motor, can be varied from 3 to 17 r.p.m., corresponding with translational speeds at the end of the arm of 6 to 35 m.p.h.

For the purpose of transmitting current to the motor driving the airscrew, and also to the measuring apparatus, during the rotation of the whirling table a set of eight slip rings are fixed to the post.

The airscrew shaft is driven by an endless rubber belt by a 2 hp. motor carried on the arm, the speed of the motor being regulated from an observation table in the corner of the whirling shed.

A small revolution counter driven by the airscrew shaft is connected electrically so as to ring a bell every hundred revolutions, the airscrew speed being timed with a stop-watch for a period of about two minutes. A second bell rings at each revolution of the whirling table, so that by timing the rings against a stop-watch the speed of rotation of the whirling table and hence the speed of translation of the airscrew due to motion of the whirling table may be calculated.

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* See the later reports of the Advisory Committee for Aeronautics.

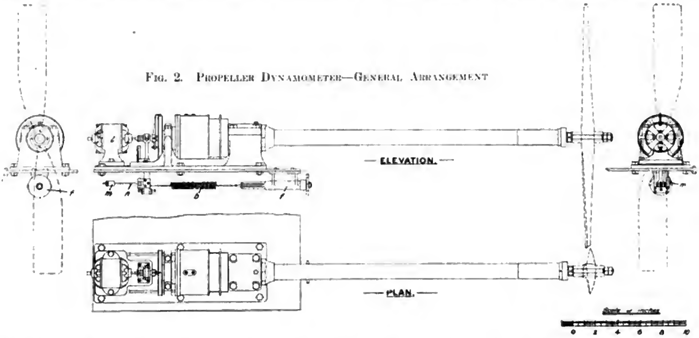

FIG. 2. PROPELLER DYNAMOMETER—GENERAL ARRANGEMENT

As would be expected, the air in the whirling shed is set in motion by the whirling table and also by the backwash of the airscrew, the velocity of translation of the airscrew through the air being obtained from the measurements of both the velocity of translation of the airscrew due to the rotation of the whirling table and the velocity of swirl of the air. The velocity of this air swirl is measured by a Pitot tube mounted at the end of a light arm opposite to that carrying the airscrew, the tube following the airscrew at a distance of about 100 ft. so that it is well out of the region of the direct action of the slip stream. The tube is connected through an airtight mercury seal at the top of the central post to one limb of a manometer, the other limb being open to the atmosphere.

If V be the velocity of the end of the whirling arm and s the velocity of the air swirl in the shed, the velocity of the tube relative to the air is $V-s$, so that taking into consideration the reduction of air pressure due to the centrifugal head in the connecting pipe the reading of the manometer is proportional to $V-s^2-V^2$, that is, s^2-2sV, from which the velocity of the swirl may be calculated since V is a measured quantity. The speed of the air swirl, when the airscrew is not working, is about 8 per cent of the arm speed.

A measurement of the air swirl is made at each determination of the performance of the airscrew since the swirl velocity depends on both the rotation speed of the whirling table and the slip stream at which the airscrew is working. At a low translational speed when the airscrew is giving a big thrust the velocity of the air swirl may be negative.

Description of the Airscrew Dynamometer

Two sketches of the airscrew dynamometer, a general arrangement and a sectional drawing, are given in Figs. 2 and 3. The dynamometer was designed to measure a maximum thrust of 15 lb. and a maximum torque of 4 lb./ft., but with model airscrews of ¼ scale measurements greater than 4 lb. for the thrust and 1 lb./ft. for the torque are rarely made.

The airscrew shaft is driven through flat coiled springs s, the extension of the springs, which is proportional to the

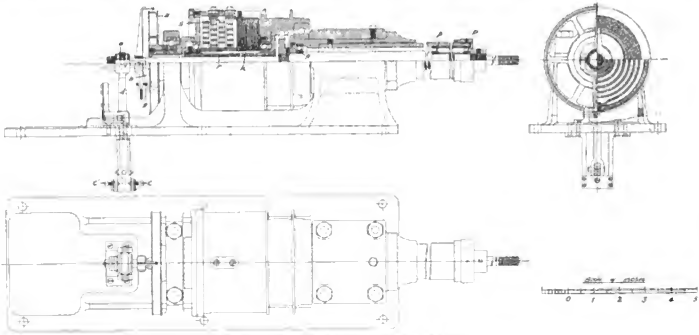

FIG. 3. PROPELLER DYNAMOMETER—SECTION

torque, being measured by the relative displacement of a pointer over a small drum *a*, which carries a small slip of paper. The position of the pointer at any time during the experiment is recorded by passing a series of sparks through the paper, so that if the zero position of the pointer is also recorded on the paper the magnitude of the torque may be directly calculated from the known calibration of the springs.

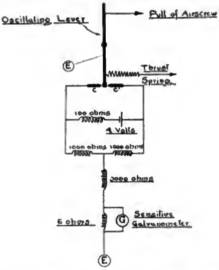

FIG. 4. DIAGRAMMATIC SKETCH OF THRUST-BALANCING APPARATUS

Alternate torque springs are wound in opposite directions so that tendencies to unwind due to centrifugal force almost counterbalance each other. A small torque correction, the magnitude of which is a function of the rotational speed, is made to each torque measurement.

The airscrew shaft is allowed a small axial movement, about 1/200 in., by the use of the ball bearings *p, p, p*, which have parallel outer races. The end of the airscrew shaft bears against an oscillating lever *d* which is pivoted at its center, the lower end of the lever being directly controlled by the thrust spring *b*, the tension in which is adjusted by the poppet head *f*, and two adjustable stops *c, c'*, both stops being insulated electrically from the rest of the dynamometer.

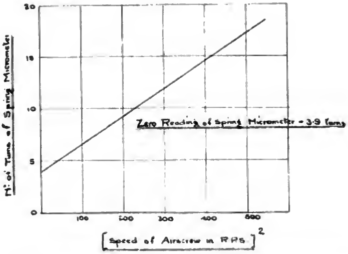

FIG. 5. READING OF POPPET HEAD PLOTTED AGAINST SQUARE OF ROTATIONAL SPEED

The method of indicating when the thrust of the airscrew is balanced by the pull of the spring is illustrated by the diagrammatic sketch of Fig. 4. From the diagram it is seen that the direction of the current through the galvanometer depends whether the lever is touching stop *c* or stop *c'*. When the thrust of the airscrew balances the pull of the spring, and the oscillating lever is floating midway between the two stops, currents of equal magnitude but of opposite direction flow through the galvanometer so that the galvanometer needle is not deflected owing to the inertia of the moving parts of the

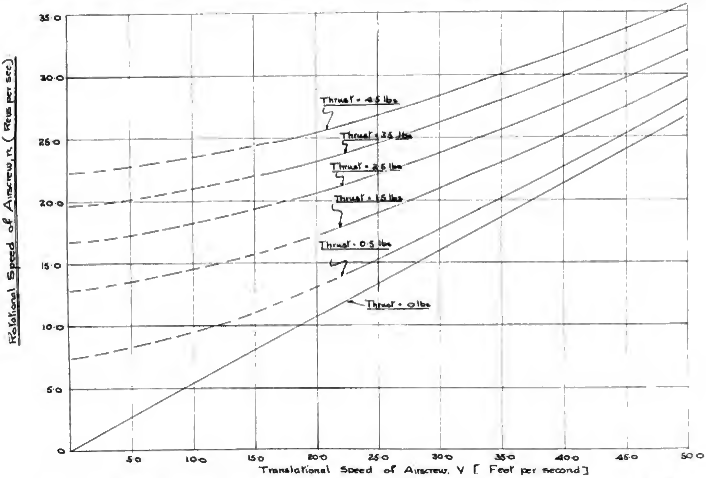

FIG. 6. RELATIONSHIP BETWEEN TRANSLATIONAL AND ROTATIONAL SPEEDS AT A CONSTANT THRUST OF AN AIRSCREW

galvanometer and the inductance of the circuit.

The sensitivity of this method of balancing is very great, and it will be noted that the accuracy is not affected by any variation of the battery voltage. Moreover, any variation of the contact resistance at either stop is very small compared with the large resistance of the circuit. Each stop has a hardened steel point which makes contact with a small flat hardened steel disc at the bottom of the oscillating lever.

Oscillations in the torque springs due to any small irregularity of the driving torque are damped considerably by the oil dash pot K, in Fig. 3. The dash pot consists of a series of concentric discs, alternate discs being attached to a sleeve carrying the inner ends of the torque springs, and to the drum, to the inside of which are fixed the outer ends of the springs. The vibrations of one end of a torque spring relative to the other are damped out by the viscosity of the oil between the two series of discs.

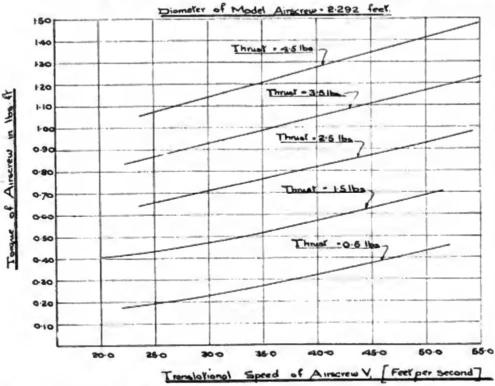

FIG. 7. RELATIONSHIP BETWEEN TRANSLATIONAL SPEED AND TORQUE AT CONSTANT THRUST OF AIRSCREW

The plane of the airscrew passes through the axis of rotation of the whirling table, and the centrifugal force due to the weight of the airscrew has no component in the direction of the thrust. The centrifugal force acting on the airscrew shaft has a small component in the direction of the thrust which is automatically corrected for by the centrifugal force of a small mass m acting through a bell crank lever n, Fig. 3.

The Method of Conducting the Airscrew Experiments

It is now proposed to describe the method of conducting an airscrew experiment, the article being illustrated with the data taken from experiments on a model airscrew. The scale of the model airscrew was ¼ full size, the diameter of the full-size airscrew being 9 ft. 2 in.

Firstly, the reading of the poppet head f, when there is no tension in the thrust spring is obtained from the static experiments on the airscrew, namely, experiments made with the airscrew rotating at a fixed point. In Fig. 5 the reading of the poppet head has been plotted against the square of the rotational speed, from which it is seen that for all practical purposes the static thrust of an airscrew is proportional to the square of the rotational speed.

The reading of the poppet head, when the airscrew is not rotating and obviously giving no thrust, is 3.9 turns, so that from the calibration of the thrust spring—3 turns represent 1 lb.—the thrust of the airscrew at any reading of the poppet head is known.

The testing of an airscrew under working conditions similar to those of practice is now commenced. The thrust spring is given a tension of known magnitude and the whirling table a steady speed of rotation, and then the speed of rotation of the airscrew is adjusted until the thrust of the airscrew balances the tension in the thrust spring, the balance being maintained for a period of about two minutes, during which time the translational speed of the end of the whirling arm, the rotational speed of the airscrew and the velocity of swirl of the air are all measured. At the moments of exact balance of the airscrew thrust, and whilst the measurements of the rotational and translational speeds of the airscrew are being made, the torque is electrically recorded.

The experiments are conducted by two observers, one observing the galvanometer of the thrust balancing apparatus, recording the torque, and measuring the rotational speed of the airscrew, the other taking the measurements of the rotational speed of the arm and the swirl velocity of the air. Usually twenty sets of observations are needed to completely define the performance of the airscrew, each set taking about 4 min.

The data of the experiments made with the model airscrew tested in this instance are given in Figs. 6 and 7. The curves of Fig. 6 show the relationship between the translational and rotational speeds of the airscrew at constant values of the thrust, from which it will be noted that the experimental mean pitch—that is, the distance moved forward into the air during one revolution, when the thrust of the airscrew is zero, is 1.88 ft.

The curves of Fig. 7 give the relationship between the torque and the translational speed at constant values of the thrust. The values of the thrust and torque of Figs. 6 and 7 are to be used for the standard atmosphere of temperature 15.6 deg. C. and pressure 760 mm., the correction factors being calculated from the observations of temperature and pressure taken during the experiments.

The curves of Figs. 6 and 7, which are plotted directly from experimental observations, are not in a convenient form for a ready calculation of the performance of the airscrew under working conditions. A more convenient and compact form of presenting the airscrew data is in terms of absolute coefficients. An absolute coefficient has the great advantage that its value is independent of the system of units employed so long as the units themselves are dynamically consistent, or, expressed simply, an absolute coefficient has no dimension.

Absolute coefficients are thus especially favorable for an international comparison of experimental data. The results of experiments as calculated from such absolute coefficients may be directly expressed in practical units on either the English or the metric system.

If V = translational speed of the airscrew.
n = rotational speed of the airscrew.
T = thrust of the airscrew.
Q = torque of the airscrew.
D = diameter of the airscrew.
and ρ = density of the air,

we may write $T = T_c \rho V^2 D^2$ or $T = T'_c \rho n^2 D^4$, so if T, ρ, V, n, and D are expressed in any system of consistent units T_c and T'_c will have no dimension and so are absolute coefficients.

In the British text-books on dynamics the units of force, mass, length and time are the poundal pound, foot and second, but the lb.-slug-foot-second system of consistent units is usually employed by the engineer. Accordingly, expressing the density of the air in slugs per cu. ft.—ρ = 0.0762 lb. per cu. ft. $= \frac{0.0762}{32.2}$, that is, 0.00237 slugs per cu. ft. at a temperature of 15.6 deg. C. and pressure 760 mm.—the value of the thrust in lb. may be calculated from the value of T_c or T'_c, if V be expressed in ft. per sec., n in revolutions per sec., and

D in ft. In a similar manner we may write either $Q = Q_c \rho V^2 D^3$ or $Q = Q'_c \rho n^2 D^5$.

In Fig. 8 the performance of the airscrew has been expressed in two ways, first, by plotting T_c and Q_c against $\left(\frac{V}{nD}\right)$, and second, by plotting T'_c and Q'_c *against* $\left(\frac{V}{nD}\right)$, $\left(\frac{V}{nD}\right)$ being also an absolute coefficient. Since $T'_c = T_c \left(\frac{V}{nD}\right)^2$ and $Q'_c = Q_c \left(\frac{V}{nD}\right)^2$, the airscrew performance may be expressed completely by plotting either T_c and Q_c against $\left(\frac{V}{nD}\right)$ or T'_c and Q'_c against $\left(\frac{V}{nD}\right)$.

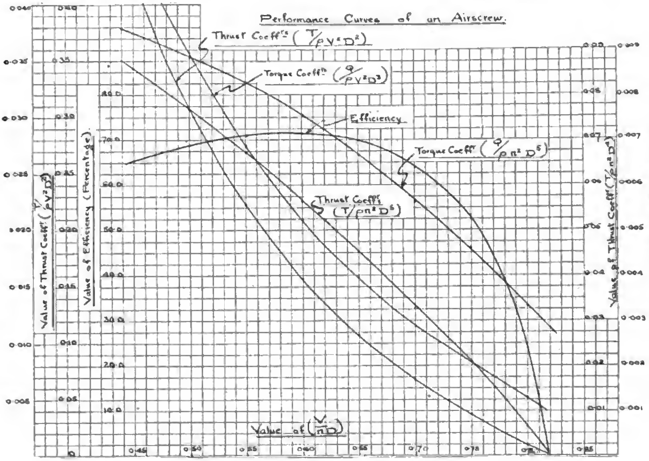

FIG. 8. PERFORMANCE CURVES OF AN AIRSCREW

The efficiency is the ratio of the useful work done by the airscrew to the total work put into the airscrew so that efficiency,

$$\eta = \frac{\text{Thrust} \times \text{Translational speed}}{2\pi \times \text{Torque} \times \text{Rotational speed}}$$

$$= \frac{T_c}{2\pi Q_c}\left(\frac{V}{nD}\right) \text{ or } \frac{T'_c}{2\pi Q'_c}\left(\frac{V}{nD}\right).$$

Efficiency being the ratio of two like quantities is, of course, an absolute coefficient. We see, then, that the performance of an airscrew may be expressed completely in two systems of absolute coefficients—either

$$(T_c, Q_c, \frac{V}{nD}, \eta) \text{ or } (T'_c, Q'_c, \frac{V}{nD}, \eta),$$

and the usefulness of such a system will be apparent from a calculation such as in the following paragraph.

To calculate the values of the thrust and torque of the airscrew at ground level, when it is moving through the air with a translational speed of 75 m.p.h. and a rotational speed of 1200 r.p.m., we express the known data in consistent units, so that

$V = 110$ ft. per sec.
$n = 20$ revs. per sec.
$D = 9.167$ ft.
$\rho = 0.00237$ slugs per cu. ft. (assuming the temperature of the air to be 15.6 deg. Cent. and the pressure 760 mm.)

The value of $\left(\frac{V}{nD}\right)$ at which the airscrew is working is $\left(\frac{110}{20 \times 9.167}\right)$ that is 0.60, the corresponding values of $\left(\frac{T}{\rho V^2 D^2}\right)$ and $\left(\frac{Q}{\rho V^2 D^3}\right)$ as measured from the curves being 0.157 and 0.0209 respectively. Hence,

$$T = 0.00237 \times (9.167)^2 \times (110)^2 \times 0.157 = 378 \text{ lb.}$$
$$Q = 0.00237 \times (9.167)^3 \times (110)^2 \times 0.0209 = 460 \text{ lb.-ft.}$$

$$\text{The efficiency} = \frac{VT}{2\pi Q n} = \left(\frac{110 \times 378 \times 100}{2\pi \times 460 \times 20}\right) \% = 72\%.$$

The thrust and torque could, of course, be calculated from the values of

$$\left(\frac{T}{\rho n^2 D^4}\right) \text{ and } \left(\frac{Q}{\rho n^2 D^5}\right).$$

Aeronautical Patents

ISSUED SEPTEMBER 18, 1917

1,240,371—To William C. Robinson, Grinnell, Iowa. Landing Chassis for Airplanes.
1,240400—To Fabian Zemojtxel, Philadelphia, Pa., assignor of one-third to Joseph Sobolowski, Philadelphia, Pa. Launching Device for Airplanes.
1,240,669—To Ellis Capps, Forest City, Ark Flying Apparatus

SEPTEMBER 25, 1917

1,240,812—To Joseph A. Blondin, Los Angeles, Cal. Airplane Construction.
1,241,072—To Stanislaw Paul Zywng, Middleton, Conn. Flying Machine
1,241,092—To Louis Coatalen, Wolverhampton, England, assignor of one-half to Sunbeam Motor Car Co., Ltd., Wolverhampton, England. Internal-Combustion Engine for Airplanes.
1,241,219—To Martin Jelalian, Cranston, R. I. Dirigible Airship for Military Purposes.

OCTOBER 2, 1917

1,241,623—To Arthur L. Gusey, Walla Walla, Wash. Aerial Vessel.
1,241,860—To James S. Lang, Boston, Mass. Plane for Flying Machines.

Description of the Austrian Albatros Biplane

Hansa-Brandenburg Type, 200 HP. Warchalowski Engine

In the Oct. 15 issue of AVIATION AND AERONAUTICAL ENGINEERING *there were published detailed drawings of the Austrian Albatros biplane, Hansa-Brandenburg type, equipped with a 200 hp. Warchalowski engine. The following official detailed description of this airplane is now made public:*

The enemy airplane described, which was captured almost intact in 1916, does not differ sensibly from those of the same type in use since the beginning of the war. It shows no substantial improvements, except slight changes with regard to the position of the radiator, the housing of the engine, the tail planes, etc. The general outline of the aircraft as regards the body, the landing gear and the main body have undergone practically no changes from the beginning of the war to this day.

To cope with the latest means of defense on land as well as in the air, the first requirement of an airplane, even if for reconnaissance work, is its high speed, whereas the Hansa-Brandenburg, judging from the pitch of the propeller, cannot exceed 155 km. That part of the angle of vision which is so highly prized by most pilots is obstructed here by the engine, which stands high for the sake of stability, and by the radiator.

Nor does the radius of action prove to be high. Judging from the speed and from the gasoline supply the machine cannot make, under the most favorable circumstances, a trip of over 550 km., which is very limited for a reconnoitering plane.

Pilot and gunner are completely exposed to the fire from enemy machine guns. Only from below are they slightly protected by a thin armor on their seats. The center of gravity of the plane, by actual calculations, has been found with full load to be 10 cm. above the axis of thrust, whereas at the end of the trip, when the fuel supply is almost exhausted, it goes as high as 20 cm. above the said axis.

The center of gravity moves about considerably longitudinally, owing to the fact that the gas tank, which serves also as seat for the pilot, is located far behind the center of gravity of the machine.

Moreover, the center of resistance is high with respect to the axis of thrust, due to radiator wind shields, machine guns, the large fixed tail plane, etc. In view of the poor location of the centers indicated, and the poor means of control, due to deficient active surfaces or to their limited action, the machine neither can be easy to handle nor show a high degree of stability.

Because of the wing section used, the position of the spars, which are very close to the leading edge, and also because of the big gap between the upper wing and the lower one, the rear upper spar receives the greatest stress, though its size is about the same as that of the front spar. If the machine is pulled sharply out of a steep dive, which has raised its speed far above normal, the angle of attack being always rather high, the point at which the lift is applied will have moved towards the middle of the wing, assuming that that point will be located at least 0.4 of the chord from the front edge; according to common mathematical data used to calculate the resistance of our machines, the coefficient is less than 5.

Neither can the static factor of safety of the body be very high, since the four longerons, which make up its frame, are much smaller than those commonly used in similar bodies of our airplanes. Therefore, the machine must be handled with care, owing to its insufficient strength.

Brief Description of the Machine

The Body.—The body is of good stream line form. The sides consist of vertical members connecting the longerons.

The framework consists of four fir longerons, properly strengthened by cross-frames and the whole rendered solid by a good triple-laminated sheathing. The smallest cross-section of the longerons at the tail end, between diaphragms, is 2 sq. cm. This cross-section gradually increases until in the front part of the machine its maximum measurement is 12 sq. cm.

Two kinds of transverse frames, varying in strength, are used. The stronger frames, which are rigid diaphragms, consist of a 15-mm. fir center, covered with two layers of 3 mm. laminated wood to increase the strength, and are placed where the body is subject to high stress. The other frames, which consist of simple non-rigid squares of fir lath, trapezoidal in shape, are used mainly to back up the laminated wood sheathing.

At the junction of the wing spars with the body, the structure is strengthened crosswise by steel tubes, 30 mm. in diameter, which make a solid piece of the whole structure. In the front part of the body the cross-framing consists of the brackets which support the engine bearers. These are made of tri-laminated wood ranging in progressive thickness from the smallest of 20 mm. to the largest of 35 mm. The engine bearers project beyond the front diaphragm of the body about 1.5 mm.

The Tail Skid.—The detail of this part of the machine is very interesting, and is evidently the result of much study, especially because of the way in which the cardan or swivel has been worked out.

The Tail Planes.—One of the characteristics of these machines is the enormous fixed tail plane, 3.84 sq. m. The elevator, which is 1.65 sq. m., is attached to the fixed plane and has exactly the same shape as the latter.

The vertical fin is rather small. It has a surface of 1 sq. m. and balances by about 1 to 5. The ribs of these planes consist of steel tubes varying in diameter from 12 to 20 mm. Only the two pairs of fixed and movable tubes, which are used respectively to support the fixed planes and the rudders, are 25 mm. in diameter. Of these two fixed tubes, both the horizontal (elevator pivot) and the vertical (rudder pivot) are braced with steel wires; in some machines the lower wires leading to the horizontal fixed tube are replaced with a tube which takes both tension and compression.

Of great interest are the details of the tubes connecting the tail planes with the end of the body and the hinges attaching the rudders to the fixed plane.

The Landing Gear.—This is of the usual wheel type with elastic springs. The chassis struts are 35 x 70 mm. tubes, filled with wood, arranged V and joined at their apex by a horizontal tube 32 mm. in diameter. The two front struts, the horizontal tube referred to above and the bottom of the body, are made perfectly rigid by crossed steel cables 6 mm. in diameter. The front diagonals are fastened to the sockets, which connect the front struts of the landing gear with the longerons of the body.

Especially worthy of note is the fact that in some machines of this type the elastic support of the axle as well as that of the tail skid is replaced by a metal spiral spring.

The cloth-covered wheels, 770 mm. in diameter and 100 mm. wide, offer nothing of interest. In the center of the axle is mounted a sprag which is operated by the pilot to lessen the run on the ground on landing. The application of such a resistance on the axle may, if not used with care, cause the machine to turn over on landing.

Gasoline Tanks.—Owing to lack of space at the center of pressure, the tanks have been placed about 400 mm. to the rear thereof and are used as a seat for the pilot.

Wing Assembly.—This differs from our biplanes in two main points, namely, the excessive stagger of the wings (the upper wing projects forward 480 mm. beyond the lower) and the inclined interplane struts with respect to the plane of longitudinal symmetry of the machine. The excessive stagger, as has been said, suggested perhaps by the necessity of increasing the range of vision of the pilot, reduces the strength of the body and probably reduces in this case the efficiency of the wings, whereas the inclined interplane struts, whose object it is to equalize the unsupported lengths of the upper and lower spars, unnecessarily complicate the whole connective system. We say unnecessarily because by placing the uprights vertically and by leaving unchanged the distribution of the trusses of the upper spar, the lower spar would most assuredly have obtained greater strength. The struts are made of tubes 32 mm. in diameter, which are faired by a small wooden frame covered with cloth.

The strut fittings on the spars are constructed in a very rough way, all weldings being autogenous; they are very heavy and offer great head resistance.

The panel bracing consists of simple steel cable of six strands, all panels use the same size of cable. The lift cables run from 7 mm. in diameter for those close to the body to 5 mm. for the outer cables, whereas the landing cables are 5 mm. near the body and 3 mm. for those of the end trusses.

The wings are perfectly symmetrical with respect to the axis of the machine, the couple of the engine being corrected by a diversity of incidence, but this gives rise to inconvenience when changing the rate of speed.

The wing section used does not turn upward, and this tends to move the center of pressure somewhat to the rear and to increase the stress on the rear spar, which is only 0.53 of the chord from the leading edge. The wing section is not very slender, because the front spar is placed too far ahead.

To prevent great horizontal strains on the wings due to head resistance, and especially due to the stagger between the wings, drift cables are used from the upper ends of the two front struts nearest to the body, which are secured to the two front ends of the longerons. Also the two forward lift wires next to the body, for the same purpose, are secured to the end of the upper forward struts of the chassis.

The wings are fastened to the body with a cabane of metal tubes, 30 mm. x 45 mm., strongly fastened to each other and forming one frame. Provision is made so that the upper wing may move slightly longitudinally so as to secure a good balance for the machine.

The lower wing almost touches the body; the attachment of the front spar is secured by means of a metal projection of suitable thickness engaging a jaw formed on a tube, which extends across the body until it reaches the other spar. The rear spar connects directly to the diaphragm, to which is also fastened the rear strut of the chassis.

The upper wings as well as the lower ones are internally braced by compression members of 25 mm. steel tube and cable 4 or 3 mm. in diameter for the bays near the body, and 3 mm. steel wire for the ends.

The diagonal in the transverse planes between the front and the rear struts are very strong, consisting of cable 4.5 mm. in diameter close to the fuse and 3.5 mm. in diameter at the ends of the wing.

RESPECTIVE WEIGHTS OF PARTS

Machine with wings, tail fins, radiator, radio outfit, gasoline, oil, machine guns, tools, etc.		614 kg.
Weight of radiator without water	25 kg.	
Weight of water	18 kg.	
		43 kg.
Tail Fins—Vertical rudder and fixed empennage, including controls	5.3 kg.	
Elevator (as above)	5.3 kg	
Fixed horizontal plane	8.4 kg.	
		19 kg.
Wings—Lower left included, only diagonals (excluding struts)	29 kg.	
Upper diagonals	37 kg.	
Lower right	29 kg.	
Upper right	38 kg.	
Struts	19 kg.	
Armament—Machine gun mounted on the wing	30 kg.	
		152 kg
Accessories	15 kg.	
Mobile gun and magazine	15 kg.	
		60 kg.
Instruments on board	5 kg.	
Radio	15 kg.	
Two pilots	150 kg.	
Gasoline	100 kg.	
Oil	15 kg.	
Feed supply behind the fixed machine gun	70 kg.	
		355 kg.
Whole weight of the machine		1,243 kg.

LOCATION OF CENTER OF GRAVITY LONGITUDINALLY

Items.	Weights.	Arms.	Moments.
Radio outfit	15	19	286
Radiator	43	61	2,620
Body, etc.	614	75	46,000
Gun on wings	122.5	98	12,000
Struts	19	105	2,000
Pilot	80	116	9,280
Lower wing	58	122	7,100
Machine gun	75	166	12,450
Mobile gun and magazines	22.5	185	4,170
Tail fins	11 8	360 391	3,960 3,128
	1,068		102,994

HEIGHT OF THE CENTER OF GRAVITY

Items.	Weights.	Arms.	Moments.
Machine gun on wing	47.5	67.5	3,200
Gunner	35	32	1,120
Radiator	43	50	2,150
Rudder	8	33	264
Machine gun	22.5	26	585
Body and accessories	614	11.5	920
Fixed fin and elevator	11	[illegible]	151
Struts	19	12	228
Pilot	80	8.5	680
Gunner	75	2.5	187
Radio outfit	15	10	150
Lower wing	58	32	1,850
	P.1,028		N.14,488

Kiln-Dried Airplane Woods

The Forest Service, Department of Agriculture, authorizes the following:

When the United States entered the war the need for wood to build airplanes quickly created a difficult problem. Most of the air-seasoned wood available had been bought for airplanes for the allied nations abroad. Through air-seasoning of such stock requires from one to three years, according to the size and kind of wood. Kiln-dried stock under the methods ordinarily used has frequently proved unsatisfactory, and for that reason airplane manufacturers have been reluctant to use it. If the needs of the fighting forces were to be met adequately and without prolonged delay, it was essential that methods of conditioning should be available in which full confidence could be placed.

Long before this situation developed the forest products laboratory of the Forest Service, at Madison, Wis., had been making a scientific study of the drying of wood, and had developed a method of drying which has been very successful with all the woods tried. Several kilns have been built at the laboratory for experimental purposes and a number of demonstrations made in commercial kilns. Ash and spruce are the woods most in demand for airplane construction, and anticipating the present situation, the Forest Service secured a shipment of partially air-seasoned ash and spruce plank for preliminary tests.

This material was kiln-dried without injury. Later thoroughly green Sitka spruce, white ash (northern and southern), white oak, Douglas fir, western white pine, and mahogany were secured in the log for testing. The spruce and ash logs were cut up and the green material from each species divided into three matched groups. One group of each species was tested green, another has been set aside to be tested when it has air-dried, and the third group was kiln-dried, trying several methods, and then tested.

Only the results of tests on the spruce have so far been analyzed. Comparison with standard tests which had already been made shows that Sitka spruce can be kiln-dried from the green condition with no more, perhaps less, injury to its mechanical properties than by air-seasoning. Definite specifications have been prepared for kiln-drying spruce green from the saw for airplane construction, and, if rigidly enforced, they will insure kiln-dried stock of this species equal to air-dried stock.

A preliminary study of propeller construction has shown the need of such information on propeller woods. The testing of the ash and other species now on hand, which include several propeller woods, is being pushed as rapidly as possible, and there seems reason to expect as favorable results as for the spruce.

Book Reviews

ACQUIRING WINGS. By William B. Stout: Moffat, Yard & Co., New York (57 pp., 75 cents).

This book gives the basic principles of aviation in simple and concise language. The fundamentals of airplane design and construction, which the ground student should know preliminary to his actual training in the air, are here dealt with more exhaustively than is often found in much more ambitious volumes. Some excellent illustrations accompany the text.

The author is a recognized expert on aeronautics and is now in Government service. Altogether this little volume should prove a valuable introductory guide to all those who are taking up the study of aviation.

LEARNING TO FLY IN THE U. S. ARMY. By E. N. Fales: McGraw-Hill Book Company, Inc., New York (177 pp.).

The contents of this book run parallel to the instruction given under the author's direction in the U. S. School of Military Aeronautics at the University of Illinois. Its contents cover, therefore, all of the theoretical part of aviation which aviator cadets are expected to have gathered during their stay in a ground school.

Comprehensive chapters are devoted to the types of military airplanes and uses; the principles of flight; the mechanics, the rigging, and erecting of airplanes; materials of construction; cross country flying, etc., etc.

This handy book, which is of pocket size, should be of the greatest help to the aviator cadet for constant reference in the preliminary stages of his training.

Finishing Up and Balancing Airplane Propellers*

By Frank W. Caldwell

After the propeller has been roughed out it is desirable to let the wood season for a while before finishing. The present American practice is to allow only a few days for this seasoning. It is the opinion of the writer, however, that longer seasoning is desirable. For proper seasoning a period of one month at a temperature of about 80 deg. Fahr. and a relative humidity of from 45 to 55 deg. is recommended.

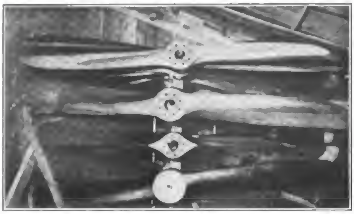

FIG. 1. RACK STAND FOR SEASONING PROPELLERS

For this seasoning the propellers should be hung up on racks similar to the one shown in Fig. 1. This rack consists of an upright wooden post 4 in. square with pieces of 1 and 1¼ in. iron pipe stuck through it.

The photograph was taken in a storeroom on the Mexican border. In this case it was found necessary to keep the floor wet down and a number of buckets of water standing in the room to maintain the humidity necessary to preserve the life of the wood.

By hanging the blades in a horizontal position a uniform circulation of air is maintained and the drying is done uniformly. After the seasoning is complete it is desirable to install the hub before any further work is done.

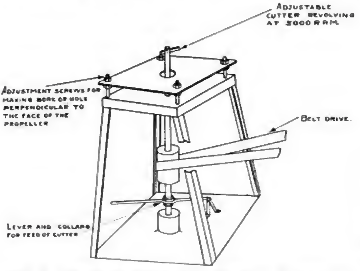
ADJUSTABLE CUTTER REVOLVING AT 5000 R.P.M.
ADJUSTMENT SCREWS FOR MAKING BORE OF HOLE PERPENDICULAR TO THE FACE OF THE PROPELLER
BELT DRIVE.
LEVER AND COLLARS FOR FEED OF CUTTER

FIG. 2. DEVICE FOR CUTTING CENTER HOLE OF PROPELLER HUBS

The hubbing practice is at present very unsettled. The European practice is to allow one sixty-fourth of an inch oversize holes for the large center hole and for the bolt holes. In this case the whole drive must depend on the friction of the flanges.

In American practice it has been considered desirable to make the hub flanges as small as possible in order to save weight. In some cases the flanges have been made so small that the friction alone was not great enough to drive. Then it was necessary to have a neat press fit of the hub in the large center hole and a driving fit of the bolts in the bolt holes, in order to make the bolts do part of the driving.

A simple calculation will show what would happen in case the friction of the hub flanges were not great enough to drive the propeller and the bolts were fitted one sixty-fourth inch loose in the holes.

Take the case of a direct drive eight-cylinder engine turning at 1400 r.p.m. There will be 4 × 1400 = 5600 pulsations per minute. Since the propeller is a flywheel it must absorb these pulsations. If the friction of the hub flanges is not great enough to drive, the flanges will slip at each pulsation until they come in contact with one side of the bolts and then slip back until they come in contact with the other side.

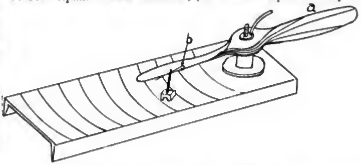

FIG. 3. "TRACKING" THE BLADES

The surface gage is set at the height of the point *a* and the propeller is swung round through 180°. The point *b* equidistant from the axis is then trimmed down by the gage to the same height as *a*.

The distance traveled by the flange will be 2 × 1/64 in. or 1/32 in. The distance traveled per minute is 5600 × 1/32 in. or 175 in. per minute. It is hardly necessary to state that the wood is soon burnished in a case like this. As a matter of fact the writer has seen propellers charred and completely burned out of shape at the hub after ten or fifteen minutes in a case of this kind.

The advantage of the European practice is that the metal hubs are easily installed and changed in the propellers. Also there is no chance of splitting the wood by a bolt that is too tight.

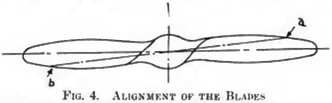

FIG. 4. ALIGNMENT OF THE BLADES

A line joining any two points *a* and *b* must pass through the axis of the propeller. This may be tried with a straight edge or with fine wire. *a* and *b* are two points on the trailing edge equidistant from the axis.

The advantage of the American method lies in the saving of weight which, of course, is of foremost importance.

In order to get a clean-cut center hole for the hub the use of a device similar to that shown in Fig. 2 is recommended.

The bolt holes should be drilled by means of a jig drilling half-way through from each face.

Before installing the hub, four or five coats of linseed oil should be applied to the inside of the hub hole and bolt holes. The whole surface covered by the hub should then be coated with shellac.

The hub bolts should be pulled up as tight as the threads will permit. Of course, it is necessary to alternate from one side to the other in tightening the bolts to avoid drawing the flanges out of line.

The propeller with the hub installed is now fastened in place on a lay-out plate. The trailing edge of one blade is now accurately cut down to correspond with the projection shown on the drawing of Fig. 3. This work is done with a spoke shave.

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* The present article is the third and last of a series dealing with the construction of airplane propellers, which has been contributed by the author to AVIATION AND AERONAUTICAL ENGINEERING, the first article having appeared in the issue of May 1, 1917, and the second in the issue of Oct. 1, 1917.

Each point on the trailing edge of the other blade is now made to "track" with the corresponding point on the first blade. Failure to track throws the propeller out of balance dynamically, but is only shown up statically by measurement. Fig. 3 shows the method of "tracking" the blades of the propeller.

After the blades are tracked it is necessary to align them so that a line passing through two corresponding points on the trailing edges will pass through the axis of revolution. Failure to align the blades will throw them out of balance statically as well as dynamically. The method of aligning is shown in Fig. 4.

The trailing edges are now used as reference lines, and the blade angles are worked down from these lines by means of a protractor or a pitch card. Care must be taken to see that the lamination lines form a fair curve between stations.

After the face has been formed the back shape is obtained by working to templates. The work is finished down to within about one-sixteenth of an inch with a spoke shave and is then finished with a patent scraper.

That portion of the blade between the hub and the first station is usually formed by the eye, the lamination lines being cut down to a fair curve.

The next operation is that of balancing. Fig. 5 shows a good form of balancing stand. The propeller is balanced in two positions, as shown in Fig. 6 and Fig. 7. It is considered desirable to remove stock for balancing from the face of the blade rather than from the back, since variations of camber of the under side of a wing have less effect on its aerodynamic properties than variations in the shape of the upper side. It is obvious that changes in the lift coefficient of a section on one blade only will throw the propeller out of balance aerodynamically.

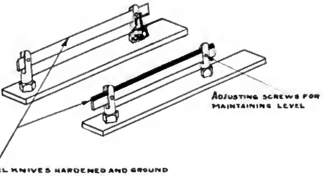
Adjusting screws for maintaining level
Steel knives hardened and ground

Fig. 5. Balancing Stand

After balancing, the propeller must be sanded to a nice surface. Three grades of sandpaper recommended are No. 2½. No. 1½ and No. ½. Care must be taken to rub along the grain and never to let the paper rub across it. A single stroke across the grain will spoil the finish unless the marks are carefully rubbed out.

The propeller should now be given about four coats of linseed oil, balancing carefully after each coat. A nice finish may be obtained by rubbing with a mixture of linseed oil and shellac. The shellac is mixed very thin with alcohol and a piece of cotton is soaked in it. A piece of cheesecloth is wrapped around the cotton to form a pad. Linseed oil is applied to the propeller in small drops and the shellac is rubbed in vigorously with the pad. Patience and a little care will enable one to get a fine polish. It requires about three hours' rubbing to properly polish a propeller.

The use of a paste filler and varnish is not recommended, as the filler does not penetrate and a small scratch will expose the wood to the weather.

Sheathing with Copper or Monel Metal

To protect the tips of the blades from the abrasive action of sand and small stones and from spray in the case of a seaplane propeller some form of sheathing is usually applied.

The question of the usefulness of sheathing does not pertain to the subject of this article. It may be stated briefly, however, that the present tendency is to use sheathing only on seaplanes.

In case copper is used for sheathing, the sheets should be carefully annealed before they are used. The sheets for the face and back side should be cut to shape and formed to the blade shape. The tips are now clamped in place and their outline is marked on the blade. A recess is cut along this outline so that the copper will come flush with the wood when the tip is applied. The copper sheets are again clamped in place and holes are bored for the rivets. A good size of rivet is about .085 in. and the holes are bored to give a driving fit in the wood.

After all the holes are bored the tips should be removed and all the holes should be filled with linseed oil. This precaution may seem superfluous to the shop man, but the rivet holes are a frequent source of season checks in the field.

The tips may now be applied permanently and the rivets driven through and beaded over. Each rivet is soldered to the copper plate and the seam where the two plates overlap is carefully soldered. The surface is filed smooth and the propeller is again balanced by the application of small amounts of solder to the light blade.

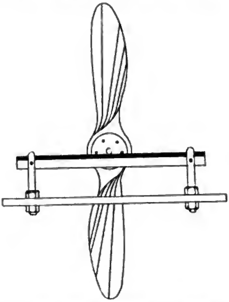

Fig. 6. Balancing the Propeller in a Vertical Position

Sheathing with Monel metal is carried out in the same way except that the metal is much more difficult to work and requires more skill in applying.

Sheathing with Linen

In case the blades are to be sheathed with linen they must be absolutely clean and no oil or other coating must be applied.

The cloth must be carefully scrubbed with washing soda and rinsed in hot water until all the sizing is removed.

The back side of the blade is coated with Scotch glue and the cloth is applied and rubbed down smooth. It is then ironed with an electric iron to improve the adhesion. The work must be done in a room at a temperature of about 100 deg.

The cloth is trimmed even along the edges. The cloth on the face side is applied in the same way except that it is allowed to lap about three-quarters of an inch over the back.

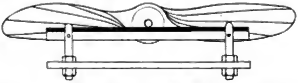

Fig. 7. Balancing the Propeller in a Horizontal Position

After the glue has set for about twenty-four hours, four coats of airplane dope may be applied, followed by two coats of battleship gray enamel.

To give a good appearance the surface should be rubbed to a French polish with oil and shellac.

The Future of Commercial Aeronautics*

By Lieut.-Col. Merwyn O'Gorman, C.B.

Commercial aeronautics is clearly one of the subjects requiring foresight, technical, political and financial. Broadly, the objective is simple, in detail it is very complex. This at once suggests analysis as a help toward foresight. Commercial aeronautics can be divided into three parts:

(*a*) The home or internal aspect.

(*b*) The foreign or international aspect.

(*c*) The Imperial and Colonial aspect.

The internal British question can be resolved into five separate subject-matters for study, and as each of these has subheads, I tabulate as follows, drawing attention to the two main heads—(1) the production, and (2) the utilization (or "aerial transit") problems, corresponding roughly to supply and demand.

It will be found that the profitable use of aircraft is based on speed, and that as speed of transit includes door-to-door movements, if there are, as we see at present, considerable terminal time losses, the longer the distance over which aerial work is conducted the less significant are the "terminal charges" upon our time of transit. This merit introduces, for a small country, the advisability of studying flight beyond its borders, and for an island the consideration that shipping is slow compared to the railroad or automobile. Therefore international flying will come up early in our development of aerial transit, and may be expected to concern movements over the sea, not necessarily in seaplanes.

TABLE A—ANALYSIS OF SUBJECTS ENTERING INTO INTERNAL BRITISH AERONAUTICS

The Uses of Aircraft	*The Safety Provision*	*Education of Personnel.*	*Production of Aircraft.*	*Labor*
				General Question
(*a*) Transit of goods.	(*a*) Aerial routes, lines of landing grounds, maps.	(*a*) Designers, engineers.	(*a*) Best employment of existing factory organization.	(*a*) Skilled and unskilled.
(*b*) Transit of letters.	(*b*) Night flying, landing.	(*b*) Flyers, navigators.	(*b*) Finance and subsidies to makers.	(*b*) Male and female, including military, wounded, pensioned, etc.
(*c*) Transit of persons.	(*c*) Aerology, meteorology.	(*c*) Military call on flyers.	(*c*) Military and naval requirements.	
(*d*) Labor of transit service.	(*d*) Wireless communication of distress, orders, signals of directions.	(*d*) Polytechnic and correspondence schools for labor.	(*d*) Publicity and "load curve orders."	
(*e*) Finance of transerial companies.	(*e*) Labor of ground upkeep, etc.	(*e*) Subvention of education	(*e*) Utilization of overplus of military and naval war orders.	
(*f*) Government subvention of aerial transport.	(*f*) Subvention of safety precautions and grounds	(*f*) Collation of data, research.	(*f*) Supply of aircraft to foreign governments and colonies.	
(*g*) Private, sporting and domestic use.	(*g*) Accidents, investigation.	(*g*) Inventions.		
(*h*) Scientific use, surveys, etc.	(*h*) Keeping of records.	(*h*) Consular trade information, etc.		
	(*i*) Insurance of—(1) pilots, (2) passengers, (3) craft			

But we cannot go abroad without our tickets, our circular notes and passport, so that we cannot fly over another country without making arrangements. These arrangements will be easily made if there is a body of opinion abroad which is favorable, which recognizes that it will not get landing rights in British possessions unless British aircraft have landing rights on foreign soil. One of many ways of securing such a body of opinion favorable to aerial transportation in the prize lands themselves is to institute industrial links between our own constructors and foreign constructors, whether as "succursales" or joint firms, or shareholders, or agents. I therefore put these first and tabulate five subheads.

If we develop our aircraft making and using properly we shall be the first to wish that other countries may be equipped with "aerial ways" (lines of landing grounds), aerodromes at big centers of industry, finance or pleasure. Moreover, we want to find elsewhere not only the maps, but also most of the safety provisions desirable at home. All these things will be fostered by the energies of societies like the Aeronautical Society and the Society of British Aircraft Constructors, which we should like to find abroad and enter into relations with. At present they are not nearly as active abroad as at home. They might be fostered not only officially, but rather through the intermediary of our industrially linked firms, whether for construction or transit.

One of the important matters for consideration is the avoidance of cutthroat competition at a time when it is always difficult to insure a remunerative investment with any certainty. This involves the inter-State provision of what may be termed limited monopoly for certain services at least, until the businesses are well launched and till statistics exist in which insurance operations can be satisfactorily based. Firms can be trusted to make their own value felt by the Post Office and by passengers whom they desire to attract, but they are defenceless against one another if as soon as one energetic individual has initiated an enterprise the value of his strenuous work is to be poached upon by irresponsible persons (who may, it is true, ruin themselves undeplored), but who may drag into a like ruin those whose industry and courage founded the whole scheme. The Government should step in here in the interest of maintaining what it must maintain, a large, successful and enterprising industry.

It may here be worth while to say why the country must do this. It is a matter of economy. The air fleet differs materially from the sea fleet in being more rapidly expendible. No one would dream of rebuilding the British fleet six or eight times per year of war. Yet the air fleet requires at least this. Thus the airplane occupies an exciting position halfway between a battleship and a cartridge. To decide on having an air fleet for war is synonymous with having an aircraft industry in peace competent to produce some eight air fleets per annum when called upon.

Commercial and Postal Uses of Aircraft

As we have recently had a suggestive paper on airplane transport, giving rough costs on a certain route, I will not dwell on it save to recall the existence of the airship and to touch on one matter which I raised in the discussion, and to which Lord Cowdray also addressed some remarks. I allude to the danger of the hiatus which might occur between the war demand and the peace demand. There appears here all the value that attaches to promptness in giving, and all the difficulties that attach to the exercise of foresight.

In another sphere we know, that to secure the return of soldiers to the land, a parliamentary commission has already recommended that immediately on the declaration of peace 20,000 cottages shall be built at or near the land they are to till, thus utilizing the building skill now in the ranks and starting the homes for our men on the land. So far as the housing of workpeople near centers of aircraft production is concerned, this may be said to have been largely provided during the war; what has not been foreseen even on paper with a like definiteness is the absorbing of our aircraft output and the incidentals thereto. The financing and laying out of the specific postal routes, the location of the mechanics, repair men and tuners at the ports of departure and arrival, the housing of aerodrome officials, groundmen, accountancy clerks, the automobile service from town to aerodrome, the purchase of land and the establishment of title, the preparation of lists of aviators who may desire to find occupation at once instead of losing their skill by many months' inactivity, the preparation of such drawings as may quickly allow of adapting war aircraft designs to their new uses, and the designing of such new weight carriers as may be more suitable to transport work; some or all of these things are needed if the industrial organization of the factories is not to crumble during a long hiatus. Six months of idleness will disrupt any factory organization, and will lead to the paying off of workpeople and their consequent suffering and discontent. This six months of idleness must not occur.

It must be admitted frankly that the preparation of such schemes is not only laborious, but dishearteningly dependent on circumstances beyond the control of the organizer. Still, just as in peace time we work out complete plans for war condition which might arise, so in war time we do paper work for peace conditions, even if some of that paper work is wasted.

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* Excerpt from the Fifth Wilbur Wright Memorial Lecture, delivered before the Aeronautical Society of Great Britain.

We have had one skeleton scheme to awaken the imagination, but we must have many to save the situation. We are confronted with the position that the mere housing of one month's output of the aircraft builders together with the returned war stocks, as soon as the rapid wastage ceases, is a matter of intense difficulty. Thus we are led to formulate the desire that sales of military aircraft to foreign countries, colonies, private users, exploitation companies at home and abroad shall be as prompt as they can possibly be made by every exercise of forethought, subject only to the retention of such devices and machines as are reserved by the military authorities for special reasons.

TABLE II ANALYSIS OF SUBJECTS ENTERING INTO FOREIGN AERONAUTICS

The formation of Industrial Links. Coordinating Technical Societies.	Post Office Reciprocity	Post-War Inter-Governmental Agreements (Allied and enemy).	Registration of Craft.	Customs and Policing Quarantine and Aliens Question.
	(a) Prices for postage. (b) Methods of collection and delivery. (c) Agreed routes.	(a) Flying rights. (b) Landing rights. (c) Rule of the "road." (d) Supply of aircraft to foreign governments. (e) International law, prohibited areas, etc.	(a) Salvage by ships and by aircraft. (b) Exchange of meteorological news.	

The policing of the air, though eventually a means of using a number of armed aircraft without appreciable alteration, can only at first consume aircraft on a small scale, however carefully such a scheme be laid out for expansion when the trade develops. It would be putting the cart before the horse to provide for more police than there are potential malefactors, or to provide for enforcing the "rules of the air" on a non-existent traffic.

Future Production of Aircraft

The bugbear of any production is the uneven distribution in time of the orders received. The intolerable burden of keeping a staff and a system to give a large rate of output for a short time and at short notice should, if possible, be put an end to by foresight. The Government will necessarily have certain orders of its own to distribute, and if it be found that, like the automobile trade, the industry is fed up by a "season demand," then the Government orders might, if possible, be distributed at such dates and in such a way as to even up the load curve.

I do not pretend to detail the good or bad effects if the army, navy, post office and "transaerian" companies and foreign and Colonial Governments all invited tenders on April 2 and placed the whole of their orders on May 2, to the gorging of the lowest tenderers and the ruin of those who made correct estimates, but I do suggest that there existed no organization prior to the war for appreciating the factory point of view in the distribution over a period of time of the business of ordering, and I also suggest that any industry with a first-class chance of a steady turnover has also a first-class chance of supplying an article at once profitably and cheaply —two terms which cannot always be justifiably found in juxtaposition.

The labor question is involved in this same consideration for the same reason. The laborer's desire for his share of wealth is no doubt accompanied by the knowledge that it must be produced to be distributed, but this is overshadowed by the conviction that the firm may fail to get more orders, that a lull may come and that he can extend the period of activity between the lulls and secure jobs for his friends by working dead slow. Abolish the lulls, and the thin excuse for slacking vanishes.

Control of Customs

It seems to me that a trading airplane can cross a frontier unseen either at great height or by using clouds or at night. It can drop packages at spots prearranged with confederates, and can, without alighting, either return to its own land or continue upon its through journey and escape being identified by a Customs House officer almost any night of the year.

In Nov., 1913, a few remarks were made on the subject of customs, and it was pointed out that a customs inspection of the contents of aircraft on departure on behalf of the country of call was unthinkable, while inspection on arrival, or on dropping goods, involves all countries in having Custom House officials over so large a part of their surface as to suggest that the number of officials would be excessive.

I think it may be decided to be impracticable and conducive to the stifling of aeronautics to make it obligatory on all entering aircraft to concentrate upon some agreed ports of entry. Such a concentration would be highly inconvenient and the delay of alighting would be contrary to the very first desideratum of an air service speed. It will be time enough later to consider the control required over aliens who might enter with diseases subject to quarantine.

Each arrival aerodrome would be liable at times to become a pandemonium of delayed and angry aeronauts. But there are other objections. One would hope to see journeys navigated on a course specially selected to utilize the enormous advantage of favoring winds, and minimize the delay and expense imposed by contrary winds, and therefore such journeys would be planned without the hampering influence of arbitrarily imposed places of call. These plans would seemingly be liable to alteration in the air according to the wind encountered, so as to obtain the best economic results. It will assist in making aeronautics a wealth-producing industry instead of a burden to the State, if it is possible to secure that through journeys be made, when desired, without any compulsory stop across one country to another.

In this tangle of difficulties there is a plan suitable for the first few years which has certainly the merit of simplicity, though probably no other, namely, that all air-borne goods should be free of duty; treating whatever advantages thereby accrued to the aerial transport companies as subvention in aid.

In the contrary event of a decision to levy duty on air-borne goods, we must consider the suggestion of a Customs police mounted on fast aircraft to pursue and watch traders.

There are many difficulties about doing this, they are probably even greater than those involved in a civil aerial police that we probably must have.

For customs purposes it would be an anachronism to shoot down a suspected smuggler at sight; we cannot board an airplane in flight, nor can we know whether he is carrying sufficient hours' fuel to be capable of out-distancing our policemen; moreover, his chance of giving his pursuer the slip by using the shelter of clouds and darkness is considerable.

At first, at any rate, it may be best to accept air-borne goods untaxed; the class of substances carried will only be those of light weight, or of high value for weight, and of these mostly the ones which derive some advantage from rapid transit.

We should, of course, be invisaging the issue of an indirect subsidy of an amount not easily knowable, but, on the other hand, we should economize on what promises to be abnormally heavy costs in collecting the duties imposed. The competition with taxed sea-borne or land-borne goods would not perhaps be very serious if we remember the greater cost both of transport and insurance of air.

As to the importation of foreign aircraft themselves, this is more easily controlled because it involves alighting. It has been suggested previously that no preferential landing charges be made against foreign trader aircraft under certain circumstances of reciprocity, and accordingly an interval of stay in a country in excess of some preordained period might constitute importation for taxation purposes or alternately the Gordian knot might be cut, and preferential encouragement given to our own aircraft (as war necessaries) on the basis of a bounty to airplanes built in the country, and so avoid attempting the alternative of a tax on imported foreign airplanes.

Winter Meetings of the S. A. E.

The Society of Automotive Engineers will hold its annual dinner at the Hotel Biltmore, New York, on Jan. 10, and a special war dinner will be held at the Hotel La Salle, Chicago, on Feb. 1.

International Aircraft Standards

(Continued from last issue)

3S7—Specifications for Alloy Steel Bars and Billets

(200,000 Lb. Per Sq. In. Tensile Strength)

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Use.—2. This steel is to be used for gears.

Material.—3. The material for these bars shall be chosen from among the I. A. S. B. standard alloy steels listed below. The composition chosen shall be stated by the manufacturer or contractor, and is further limited as follows: Carbon, not over 0.50 per cent; phosphorus, not over 0.03 per cent; sulphur, not over 0.03 per cent.

Manufacture.—4. (*a*) The steel shall be manufactured or at least finished by the electric furnace or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar. No undercutting in chipping will be allowed.

Heat Treatment.—(*d*) The steel manufacturer shall state the heat treatment recommended to give the physical properties specified.

(*e*) If the bars are furnished in the heat-treated condition and the mechanical tests show that the heat treatment has not been correct, the bars may be re-treated at the option of the purchaser.

Workmanship and Finish.—5. (*a*) The bars are to be sound, commercially straight, free from pipes, laps, twists, seams, and damaged ends, and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture, capable of being turned and threaded readily and of taking a good finish.

(*b*) Any article may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously passed the physical and chemical tests; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—6. (*a*) The bars shall have the following physical properties:

Tensile Test.—(*b*) Minimum tensile strength, 200,000 lb. per sq. in. (140.60 kg./mm.^{2}); minimum yield point, 160,000 lb. per sq. in. (112.48 kg./mm.^{2}); minimum elongation in 2 in. (50.8 mm.) or proportional gage length, 10 per cent; minimum reduction of area, 35 per cent.

Impact Test.—(*c*) When impact-testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact of rupture in foot-pounds (or in kilogram-meters). Results markedly lower than the average of this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Selection of Test Specimens.—7. Three bars of each size rolled from a heat shall be taken, and test pieces prepared in accordance with I. A. S. B. standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended, fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser, the steel manufacturer may recommend a different heat treatment for the second set of test specimens, and to that end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the final test fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected.

Dimensions and Tolerances.—8. The dimensions and tolerances shall be those given by the specifications 3S11.

Delivery, Packing and Shipping.—9. (*a*) The bars may be delivered in the annealed or in the heat-treated condition.

(*b*) The steel manufacturer must stamp the heat number and the I. A. S. B. steel serial numbers on each bar of material furnished for this specification, where the bars are not less than 1½ sq. in. (968 sq. mm.) in cross section.

(*c*) Where bars are less than 1½ sq. in. (968 sq. mm.) in cross section and are not stamped with the heat and serial numbers, they shall be bundled into lots of not more than 150 lb. (68 kg.) per bundle, and the heat number and the I. A. S. B. steel serial numbers must be stamped on a metal tag attached to each of the bundles.

Chemical composition of standard alloy steels.

NICKEL STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium
2335	0.30-0.40	0.50-0.80	0 040	0.045	3 25-3.75	....

NICKEL-CHROMIUM STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium.
3140	0.35-0.45	0.50-0.80	0.040	0.045	1.00-1.50	0.45-0.75
3240	.35- .45	.30- .60	.040	.045	1.50-2 00	.90-1.25
X3340	35- 45	.45- .75	.040	.045	2.75-3.25	.70- .95
3330	.25- .35	.30- .60	.040	.045	3.25-3.75	1.25-1.75
3340	.35- .45	.30- .60	.040	.045	3.25-3.75	1 25-1 75
X3440	.35- .45	.30- .60	.040	.045	4 00-5.00	1.00-1.50

CHROMIUM VANADIUM STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Chromium.	Vanadium, minimum.
6140	0.35-0.45	0.50-0.80	0.040	0.045	0.80-1 10	0 15

3S8—Specifications for Alloy Steel Bars and Billets

(225,000 Lb. Per Sq. In. Tensile Strength)

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Use.—2. This steel is to be used for gears.

Material.—3. The material for these bars shall be chosen from among the I. A. S. B. standard alloy steels listed below. The composition chosen shall be stated by the manufacturer or contractor, and is further limited as follows: Carbon, not over 0.50 per cent; phosphorus, not over 0.03 per cent; sulphur, not over 0.03 per cent.

Manufacture.—4. (*a*) The steel shall be manufactured or at least finished by the electric-furnace or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar. No undercutting in chipping will be allowed.

Heat Treatment.—(*d*) The steel manufacturer shall state the heat treatment recommended to give the physical properties specified.

(*e*) If the bars are furnished in the beat-treated condition and the mechanical tests show that the heat treatment has not been correct, the bars may be retreated at the option of the purchaser.

Workmanship and Finish.—5. (*a*) The bars are to be sound, commercially straight, free from pipes, laps, cracks, twists, seams, and damaged ends, and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture, capable of being turned and threaded readily and of taking a good finish.

(*b*) Any article may be rejected because of injurious defects or faults in manufacture at any time; notwithstanding that it has previously passed the physical and chemical tests, it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—6. (*a*) The bars shall have the following physical properties:

Tensile Test.—(*b*) Minimum tensile strength, 225,000 lb. per sq. in (158.18 kg./mm.^{2}); minimum yield point, 180,000 lb. per sq. in. (126.54 kg./mm.^{2}); minimum elongation in 2 in. (50.8 mm.) or proportional gage length, 9 per cent; minimum reduction of area, 30 per cent.

Impact Test.—(*c*) When impact-testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture in foot-pounds (or in kilogram-meters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Selection of Test Specimens.—7. Three bars of each size rolled from a heat shall be taken, and test pieces prepared in accordance with I. A. S. B. standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended, fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser, the steel manufacturer may recommend a different heat treatment for the second set of test specimens, and to that end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the final test fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected.

Dimensions and Tolerances.—8. The dimensions and tolerances shall be those given by the specifications 3S11.

Delivery, Packing and Shipping.—9. (*a*) The bars may be delivered in the annealed or in the heat-treated condition.

(*b*) The steel manufacturer must stamp the heat number and the I. A. S. B. steel serial numbers on each bar of material furnished for this specification, where the bars are not less than 1½ sq. in. (968 sq. mm.) in cross section.

(*c*) Where bars are less than 1½ sq. in. (968 sq. mm.) in cross section and are not stamped with the heat and serial numbers, they shall be bundled into lots of not more than 150 lb. (68 kg.) per bundle and the heat number and the I. A. S. B. steel serial numbers must be stamped on a metal tag attached to each of the bundles.

Chemical composition of standard alloy steels.

NICKEL STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium.
2335	0.30-0.40	0.50-0.80	0.040	0.045	3.25-3.75	....

NICKEL-CHROMIUM STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium.
3140	0.35-0.45	0.50-0.80	0.040	0.045	1.00-1.50	0.45-0.75
3240	.35- .45	.30- .60	.040	.045	1.50-2.00	.90-1.25
X3340	.35- .45	.45- .75	.040	.045	2.75-3.25	.70- .95
3340	.35- .45	.30- .60	.040	.045	3.25-3.75	1.25-1.75
X3440	.35- .45	.30- .60	.040	.045	4.00-5.00	1.00-1.50

CHROMIUM VANADIUM STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Chromium.	Vanadium, minimum.
6140	0.35-0.45	0.50-0.80	0.040	0.045	0.80-1.10	0.15

3N1—Specifications for Gun-Metal Castings

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. The chemical composition shall be as follows: Copper, 87 to 89 per cent; tin, 9 to 11 per cent; zinc, 1 to 3 per cent; iron, 0.2 per cent. maximum; lead, 0.2 per cent, maximum.

Manufacture.—3. (*a*) The material must be made from lake or electrolytic copper according to the I. A. S. B. specification 2N2 and pig tin having a purity of at least 99 per cent.

(*b*) No scrap shall be used, except such as may accumulate in the manufacturer's plants from material of the same composition and of their own make.

Workmanship and Finish.—4. Castings must be homogeneous and free from shrinkage cracks, spongy spots, blowholes, and foreign matter. Any castings developing defects in machining must be replaced by the manufacturer. The full weight of material in the original casting must be returned by the purchaser for each replacement.

Physical Properties and Tests.—5. Gun-metal castings shall have the following physical properties: Minimum tensile strength, 30,000 lb. per sq. in. (21.09 kg./mm.²); minimum yield point, 15,000 lb. per sq. in. (10.55 kg./mm.²); minimum elongation, 15 per cent in 2 in. (50.8 mm.).

Selection of Test Specimen.—6. (*a*) The test bars shall be cast to size either from the casting, if the size of the same will permit, or from a separate block. The test bar shall be connected with the casting or block by a ⅛-in. (3.18 mm.) gate running the entire length of the test bar.

(*b*) The total length of the test bar shall be at least 6 in. (152.4 mm.), the length between shoulders 2¾ in. (69.85 mm.), the diameter of the reduced section approximately 0.57 in. (14.48 mm.) for a length of 2¼ in. (57.15 mm.).

(*c*) This test bar, when detached from the casting, shall be machined according to the I. A. S. B. standard test bar 0.505 in. (12.83 mm.) in diameter.

(*d*) The test bars and casting shall have the heat number cast or stamped on the pieces.

(*e*) At least two test bars shall be cast from each heat.

(*f*) One test shall be made to represent each heat, but in case of a flaw in the test bar or a break outside of the middle third of the gage length, further tests may be made on extra test pieces, as provided for in the foregoing paragraph.

Dimensions and Tolerances.—7. All castings must be true to pattern with correctly placed cores.

3S9—Specifications for Alloy Steel Bars and Billets for Case Hardening

(165,000 Lb. Per Sq. In. Tensile Strength)

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. The material for these bars shall be chosen from among the I. A. S. B. standard alloy steels listed below. The composition chosen shall be stated by the manufacturer or contractor; it is further limited as follows: Carbon, not over 0.25 per cent.

Manufacture.—3. (*a*) The steel shall be manufactured or at least finished by the open-hearth, electric furnace, or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) The billets from which the bars are made are to be rough-turned or chipped to remove all surface defects which might produce seams in the finished bar. No undercutting in chipping will be allowed.

(*d*) The steel manufacturer shall state the heat treatment recommended for case hardening this steel and to give the physical properties specified.

Workmanship and Finish.—4. (*a*) The bars are to be sound, commercially straight, free from pipes, laps, cracks, twists, seams, and damaged ends, and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture, capable of being turned and threaded readily and of taking a good finish.

(*b*) Any article may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously passed the physical and chemical tests; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—5. The bars shall have the following physical properties:

Tensile Test.—(*a*) Minimum tensile strength, 165,000 lb. per sq. in. (116.00 kg./mm.²); minimum yield point, 150,000 lb. per sq. in. (105.45 kg./mm.²); minimum elongation in 2 in. (50.8 mm.) or proportional gage length, 14 per cent.

Hardness Test.—(*b*) After carbonizing, hardening, and tempering, the case must show a minimum Shore scleroscope hardness number of 75.

Impact Test.—(*c*) When impact-testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture of the core in foot-pounds (or kilogram-meters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Selection of Test Specimens.—6. Three bars of each size rolled from a heat shall be taken and test pieces prepared in accordance with the I. A. S. B. standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended by the steel manufacturer, fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser, the steel manufacturer may recommend a different heat treatment for the second set of test specimens, and to that end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the final tests fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected.

Dimensions and Tolerances.—7. The dimensions and tolerances shall be those of the specifications 3S11.

Delivery, Packing and Shipping.—8. (*a*) The bars shall be delivered in the annealed state

(*b*) The bars shall in general be grouped in bundles weighing not more than 250 lb. (113.4 kg.), unless otherwise agreed between manufacturer and purchaser; the heat number and the I. A. S. B. steel serial numbers shall be plainly marked on a metal tag attached

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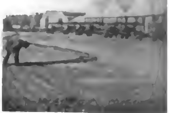

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to each bundle. If bars are not so grouped and bundled, each bar shall be plainly marked with the heat number and the I. A. S. B. steel serial number.

Hardness Test.—(*b*) After carbonizing, hardening, and tempering, the case must show a minimum Shore scleroscope hardness number of 75.

Chemical compositions of standard alloy steels.

NICKEL STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium.
2315	0.10-0.20	0.30-0.60	0 040	0.045	3.25-3.75	....
2320	.15- .25	.30- 60	.040	.045	3.25-3.75	....

NICKEL-CHROMIUM STEELS.

3120	0.15-0.25	0.30-0.60	0 040	0.045	1.00-1.50	0 45-0.75
3215	.10- .20	.30- .60	040	.045	1.50-2.00	.90-1.25
X3315	.10- .20	.30- .60	040	.045	2.75-3.25	.70- .95
3315	.10- .20	.30- .60	.040	.045	3.25-3.75	1 25-1 75

CHROMIUM VANADIUM STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Chromium.	Vanadium, minimum.
6120	0.15-0.25	0.30-0.60	0.040	0.045	0.60-0.90	0.15

When electric or crucible furnace steel is specified, the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

3S10—Specifications for Alloy Steel Bars and Billets for Case-Hardening

(180,000 Lb. Per Sq. In. Tensile Strength)

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. The material for these bars shall be chosen from among the I. A. S. B. standard alloy steels listed below. The composition chosen shall be stated by the manufacturer or contractor; it is further limited as follows: Carbon, not over 0.20 per cent.

Manufacture.—3. (*a*) The steel shall be manufactured or at least finished by the open-hearth, electric furnace, or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar. No undercutting in chipping will be allowed.

(*d*) The steel manufacturer shall state the heat treatment recommended for case-hardening this steel and to give the physical properties specified.

Workmanship and Finish.—4 (*a*) The bars are to be sound, commercially straight, free from pipes, laps, cracks, twists, seams, and damaged ends, and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture, capable of being turned and threaded readily and of taking a good finish.

(*b*) Any article may be rejected because of injurious defects or faults in manufacture at any time notwithstanding that it has previously passed the physical and chemical tests; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—5. The bars shall have the following physical properties:

Tensile Test.—(*a*) Minimum tensile strength, 180,000 pounds per square inch (126.54 kg./mm.²); minimum yield point, 170,000 lb. per sq. in. (119.51 kg./mm.²); minimum elongation in 2 in. (50.8 mm.) or proportioned gage length, 12 per cent.

Impact Test.—(*c*) When impact-testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture of the core in foot-pounds (or kilogram-meters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Selection of Test Specimens.—6. Three bars of each size rolled from a heat shall be taken and test pieces prepared in accordance with the I. A. S. B. standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended by the steel manufacturer, fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser, the steel manufacturer may recommend a different heat treatment for the second set of test specimens, and to that end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the final tests fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected.

Dimensions and Tolerances.—7. The dimensions and tolerances shall be those of the specifications 3S11.

Delivery, Packing and Shipping.—8. (*a*) The bars shall be delivered in the annealed state.

(*b*) The bars shall in general be grouped in bundles weighing not more than 250 lb. (113.4 kg.), unless otherwise agreed upon between manufacturer and purchaser; the heat number and the I. A. S. B. steel serial numbers shall be plainly marked on a metal tag attached to each bundle. If bars are not so grouped and bundled, each bar shall be plainly marked with the heat number and the I. A. S. B. steel serial number.

When electric or crucible furnace steel is specified, the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

3N5—Specifications for Naval Brass or Equivalent Alloy Sheet

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. (*a*) The chemical composition of the brass shall be as follows:

	Per cent.
Copper	59 to 63
Tin	0 5 to 1 5
Iron, maximum	0 10
Lead, maximum	0.3
Zinc	Remainder

(*b*) Samples for analysis shall be taken by boring completely through the plate at various points across both ends.

Manufacture.—3. (*a*) The material must be made from lake or electrolytic copper according to I. A. S. B. specifications 2N2 and virgin spelter of A or B grade, according to I. A. S. B. specifications 2N3.

(*b*) No scrap shall be used, except such as may accumulate at the manufacturer's plants from material of the same composition and of their own make.

Workmanship and Finish.—4. The material shall be free from all injurious defects. It shall be clean, straight, smooth, shall lie flat, and shall be of uniform color, quality, and size.

Physical Properties and Tests.—5. (*a*) The sheets shall show the following physical properties:

Tensile test.—(*a*) Plates less than ½ in. (12.7 mm.) thick and less than 30 in. (762 mm.) wide shall have a minimum tensile strength of 56,000 lb. per sq. in. (39.37 kg./mm.²), minimum yield point of 28,000 lb. per sq. in. (19.68 kg./mm.²), minimum elongation of 30 per cent in 2 in. (50.8 mm.); over ½ in. (12.7 mm.) thick, minimum tensile strength of 56,000 lb. per sq. in. (39.37 kg./mm.²), minimum yield point of 27,000 lb. per sq. in. (18.98 kg./mm.²), minimum elongation of 35 per cent in 2 in. (50.8 mm.); less than ½ in. (12.7 mm.) thick and over 30 in. (762 mm.) wide, minimum tensile strength of 54,000 lb. per sq. in. (37.96 kg./mm.²), minimum yield point of 27,000 lb. per sq. in. (18.98 kg./mm.²), minimum elongation of 35 per cent in 2 in. (50.8 mm.).

Bending test.—(*b*) Strips cut from plates shall stand being bent cold through an angle of 180 deg. in any direction to a radius equal to the thickness of the plate without fracture.

Selection of Test Specimens.—6 One tensile-test speciment and one bending-test specimen shall be taken for each lot of 500 lb. (226.8 kg.) or fraction thereof. If any test specimen breaks outside of the middle third of the gage length a retest will be allowed.

Dimensions and Tolerances.—7. (*a*) The weight or thickness shall not vary more than 5 per cent from that specified. Thickness will be specified in decimals of an inch or millimeter and shall correspond to the ordinary gage numbers.

(*b*) For wide sheets or plates above 48

Chemical compositions of standard alloy steels.

NICKEL-CHROMIUM STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium.
X3315	0.10-0 20	0.30-0 60	0 040	0.045	2 75-3 25	0.70-0.95
3315	10- 20	30- 60	040	045	3.25-3 75	1 25-1 75

in. (1219 mm.) to and including •0 in. (1524 mm.) a tolerance of 5 per cent over or 7 per cent under gage or weight will be allowed.

(*c*) For extra wide sheets or plates above 60 in. (1524 mm.) in width the tolerance may be 5 per cent over or 8 per cent under gage or weight.

(*d*) For the purpose of calculating weights, etc., the specific gravity of the alloy shall be taken as 8.404 at 20 deg. C., or 0.3036 lb per cu. in. (8.404 grams/cm.^{3}).

Delivery, Packing, and Shipping.—8. (*a*) Plates and sheets shall be cut to the required dimensions and shall be ordered in as narrow widths as can be used.

(*b*) The following will be considered stock lengths for naval brass sheets when ordered in 10 ft. (3048 mm.) lengths; 40 per cent in weight may be in 8 to 10 ft. lengths (2438 to 3048 mm.), 30 per cent in weight may be in 6 to 8 ft. lengths (1829 to 2438 mm.), 20 per cent in weight may be in 4 to 6 ft. lengths (1219 to 1829 mm.), 10 per cent in weight may be in 2 to 4 ft. lengths (610 to 1219 mm.).

(*c*) No lengths less than 2 ft. (610 mm.) will be accepted, and the total weight of all pieces on lengths less than 10 ft. (3048 mm.) must not exceed 40 per cent in any one shipment.

3S12—Specifications for High-Strength Steel Wire

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. The wire shall be manufactured of either I. A. S. B. standard steel No. 1065, No. 1070, or No. 1080, the compositions of which are listed below.

Manufacture.—3. The steel used shall be manufactured by the acid open-hearth process. Every reasonable precaution shall be taken to keep different heats carefully separated and identified throughout the rolling and drawing of the wire and to the final stage of inspection and shipment.

(*b*) It shall be uniformly coated with pure tin, to solder readily.

Workmanship and Finish.—4. The wire shall be cylindrical and smooth and may show no evidence of scrapes, splints, cold shuts, rough tinning, or other defects not in accordance with best commercial practice.

Physical Properties and Tests.—*Tensile Test.*—5. (*a*) Samples for the tensile test shall be not less than 15 in. (381 mm.) long and free from bend and kinks. In making tensile tests on aircraft wire, the distance between jaws of testing machine, with the sample in place and before test, shall be 10 in. (254 mm.). The wire must not break at less than the amount specified in the attached table, which is a part of this specification.

Torsion Test—(*b*) Samples for the torsion test shall be straight and not less than 10 in. (254 mm.) long. The sample shall be gripped by two vises 8 in. (203.2 mm.) apart; one vise shall be turned uniformly at a speed not exceeding 60 revolutions per minute (on the larger sizes of wire this speed shall be reduced sufficiently to avoid undue heating of the wire). One vise shall have free axial movement in either direction. All wire shall be required to withstand the minimum number of complete turns shown in the attached table, and which are calculated from the relation:

$$\text{Number of turns} = \frac{2.7}{\text{diameter in inches}} = \frac{68.6}{\text{diameter in millimeters.}}$$

Bend Test.—(*c*) Samples for bend test shall be straight and not less than 10 in. (254 mm.) long. One end of the sample shall be clamped between jaws having their upper edges rounded with 3/16 (0.188) in. (4.76 mm.) radius. The free end of the wire shall be held loosely between two guides and bent 90 deg. over one jaw; this is to be counted as one bend. On raising to a vertical position the count will be two bends. Wire shall then be bent to the other side, and so forth, alternating to fracture. The minimum number of bends required is stated in the attached table.

Wrapping Test.—(*d*) A wrapping test is to be made on at least 10 per cent of the total number of coils offered for inspection at one time. The wire is wrapped around its own diameter eight consecutive turns with a pitch substantially equal to the diameter of the wire and then unwrapped, maintaining the free end at approximately 90 deg. with the mandrel. It must stand this test without fracture. Because of the possibility of personal error in making this test, failure on one test is not considered conclusive, and if required to do so the inspector shall make at least one, but no more than two, additional tests on the sample of wire. If any of these tests are successful, the material shall be passed as satisfactory in this respect.

Selection of Test Specimen.—6. A tensile, a torsion, and a bend test shall be made on each end of each piece of coil or wire. When an individual coil of wire is to be divided into smaller coils to meet special requirements, it is sufficient to make one test on the original coil and to cut and seal the small coils in the presence of the inspector.

Dimensions and Tolerances.—7. (*a*) All wire for this purpose shall be furnished in decimal sizes corresponding to the American Wire Gage (Brown & Sharpe gage).

(*b*) A permissible variation of 0.002 in. (0.051 mm.) above gage on all sizes will be accepted, but no wire will be accepted having a variation of more than 0.0005 in. (0.013 mm.) below gage.

Delivery, Packing and Shipping.—8. (*a*) Wire covered by this specification shall be shipped in coils or bundles wrapped closely with a layer of plain strong paper in strips no less than 3 in. (76.2 mm.) wide and then covered with another wrapping of waterproof paper of an approved quality.

(*b*) The size and weight of packages or coils shall conform to the following unless otherwise specified on orders: 0.072 in. (1.828 mm.) and larger, mean diameter of coils 22 in. (559 mm.), minimum weight of coil 25 lb. (11.34 kg.); 0.064 in. (1.628 mm.) and smaller, mean diameter of coils 12 in. (305 mm.), minimum weight of coil 10 lb. (4.54 kg.).

Inspection and Rejection.—9. A tag supplied by the manufacturer and filled in by the Government inspector with ink, showing the number of the test as per his official list of tests, the diameter of the wire, the breaking strength, and torsion and bend tests, shall be attached to each coil or piece of wire accepted by him or by the salvage board. Such tag shall be sealed on the bundle with a steel wire of approved design and a lead seal bearing the private mark of the inspector doing the work.

Chemical composition of standard carbon steels.

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum,
1065	0.60-0.70	0.50-0.70	0 040	0 045
1070	.65- 75	.50- .70	040	.045
1080	.75- 90	25- .50	040	.045

Table of physical properties, weights and sizes.

ENGLISH UNITS.

American Wire Gage.	Diameter in inches	Minimum torsion in 8 in.	Weight in pounds per 100 ft.	Number of bends through 90 deg.	Breaking strength, minimum lbs.	Tensile strength in pounds per sq. in.
6	0.162	16	7.01	5	4,500	219,000
7	.144	19	5.56	6	3,700	229,000
8	.129	21	4.40	8	3,000	233,000
9	.114	23	3.50	9	2,500	244,000
10	.102	26	2 77	11	2,000	244,000
11	.091	30	2 20	14	1,620	254,000
12	.081	33	1.744	17	1,300	252,000
13	.072	37	2.383	21	1,040	255,000
14	.064	42	1.097	25	830	258,000
15	.057	47	.870	29	660	259,000
16	.051	53	.690	34	540	264,000
17	.045	60	.547	42	425	267,000
18	.040	67	.434	52	340	270,000
19	036	75	.344	70	280	275,000
20	032	85	.273	85	225	280,000
21	028	96	.216	105	175	284,000

METRIC UNITS.

American Wire Gage.	Diameter in millimeters.	Minimum torsion in 203.2 mm	Weight in kilograms per 100 m.	Number of bends through 90 deg.	Breaking strength, minimum kilograms.	Tensile strength, in kilograms per square millimeter.
6	4.115	16	10.44	5	2,041	954.0
7	3 665	19	8.28	6	1,678	161 1
8	3 264	21	6.55	8	1,361	163 8
9	2 906	23	5.21	9	1,134	171.6
10	2 588	26	4 12	11	907	171 6
11	2.305	30	3.28	14	735	178 6
12	2.053	33	2.597	17	590	177.2
13	1.828	37	2.060	21	472	179 4
14	1.628	42	1.635	25	376.5	181.5
15	1 450	47	1.295	29	297 6	182.1
16	1.291	53	1.028	34	244 9	185.6
17	1.150	60	.814	42	192 8	187 7
18	1 024	67	.646	52	152 4	189 8
19	9116	75	.512	70	127.0	193 4
20	.8118	85	.406	85	102 1	196.8
21	7230	95	.322	105	79 4	199.6

2N2—Specifications for Ingot Copper

General—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material—2. (*a*) Copper may be either lake copper originating on the northern peninsula of Michigan, U. S. A., or it may be electrically refined copper.

Analysis—(*b*) The copper in all shapes shall have a purity of at least 99.880 per cent, as determined by electrolytic assay, silver being counted as copper.

Sampling—(*c*) One bar, cake, billet, ingot, or slab shall be taken for analysis from each lot of 5,000 lb. (2,268 kg.) or less, but not more than 10 bars, cakes, billets, ingots, or slabs need be taken from a carload.

Identification and Marking—3. All wire bars, cakes, slabs, and billets shall be stamped with the maker's brand and furnace charge mark. Ingots and ingot bars shall have a brand stamped or cast in, but need have no furnace charge mark.

Delivery, Packing, and Shipping—4. The refiner shall arrange carloads or lots so that as far as possible each shall contain pieces from but one furnace charge, in order to facilitate testing by the user.

References: A. S. T. M. Specifications B5—13.

2N3—Specifications for Spelter

General—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material—2. (*a*) Under these specifications virgin spelter—that is, spelter made from ore or similar raw material by a process of reduction and distillation or by electrolysis and not produced from reworked metal—is recognized in five grades, as follows:

A..	High Grade.
B..	Intermediate.
C..	Brass Special.
D..	Selected.
E..	Prime Western.

Composition.—(*b*)

A. High Grade.—The spelter shall not contain over:

	Per cent.
Lead.	0.07
Iron....	.03
Cadmium..	.07

It shall be free from aluminum. The sum of the lead, iron, and cadmium shall not exceed 0.10 per cent.

B. Intermediate.—The spelter shall not contain over:

	Per cent.
Lead..	0.20
Iron......	.03
Cadmium ..	.50

It shall be free from aluminum. The sum of the lead, iron, and cadmium shall not exceed 0.50 per cent.

C. Brass Special.—The spelter shall not contain over:

	Per cent.
Lead.	0.60
Iron.....	.03
Cadmium...	.50

It shall be free from aluminum. The sum of the lead, iron, and cadmium shall not exceed 1 per cent.

D. Selected.—The spelter shall not contain over:

	Per cent.
Lead.	0.80
Iron......	.04
Cadmium...	.75

It shall be free from aluminum. The sum of lead, iron, and cadmium shall not exceed 1.25 per cent.

E. Prime Western.—The spelter shall not contain over:

	Per cent.
Lead	1.60
Iron.	.08

Sampling.—(*c*) One slab shall be taken for analysis from each lot of 5,000 lb. (2,268 kg.) or less, but not more than 10 slabs need be taken from a carload. Saw each slab completely across from the middle of one long side to the middle of the other and use the sawdust as the sample; or drill three 9-mm. holes along one diagonal of each slab, boring completely through and taking care to make fine drilling; the holes should be drilled as nearly as possible at the middle and halfway between either end and the middle of such diagonals. Go over the drillings or sawings with a powerful magnet to take out any iron which may have come from the drill or saw, and mix the sample thoroughly. The drill or saw must be thoroughly cleaned before use, and no lubricant shall be used in either drilling or sawing.

Identification and Markings—3. A brand shall be cast in each slab by which the maker and grade can be identified.

References: A. S. T. M. Specifications B6—14 revised.

3N2 Specifications for Manganese Bronze Castings

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. The chemical composition shall be as follows: Copper, 56 to 60 per cent; zinc, 37 to 41 per cent; hardening constituents (which may include tin, iron, manganese, and aluminum), 3 per cent maximum; lead, 0.15 per cent maximum.

Manufacture.—3. (*a*) The material must be made from lake or electrolytic copper according to the I. A. S. B. specification 2N2 and virgin spelter of A or B grade according to I. A. S. B. specification 2N3.

(*b*) No scrap shall be used, except such as may accumulate in the manufacturer's plants from material of the same composition and of their own make.

Workmanship and Finish.—4. Castings must be homogeneous and free from shrinkage cracks, spongy spots, blowholes, and foreign matter. Any castings developing defects in machining must be replaced by the manufacturer. The full weight of material in the original casting must be returned by the purchaser for each replacement.

Physical Properties and Tests.—5. Manganese bronze castings shall have the following physical properties: Minimum tensile strength, 70,000 pounds per sq. in. (49.21 kg./mm.²); minimum yield point, 30,000 pounds per sq. in. (21.09 kg./mm.²); minimum elongation, 15 per cent in 2 in. (50.8 mm.).

Selection of Test Specimen.—6. (*a*) The test bars shall be cast either on the casting, if the size will permit, or on the bottom of a 3-in. square test block sufficiently long to accommodate the test bar. Chills shall not be allowed in casting the test bar.

(*b*) The test bars and casting shall have the heat number cast or stamped on the pieces.

(*c*) At least two test bars shall be cast from each heat.

(*d*) One test shall be made to represent each heat, but in case of a flaw in the test bar or a break outside of the middle third of the gage length, further tests may be made on extra test pieces, as provided for in the foregoing paragraph.

Dimensions and Tolerances.—7. All castings must be true to pattern with correctly placed cores.

3N4—Specifications for Naval Brass or Equivalent Alloy Bars

General.—1. The general specifications, 1G1 shall form, according to their applicability, a part of these specifications.

Use.—2. The material required under this specification is intended primarily for airplane turnbuckle barrels.

Material.—3. The chemical composition shall be as follows:

	Per cent.
Copper.	59 to 63.
Tin	0.5 to 1.5
Iron, maximum	0.10
Lead, maximum	0.3
Zinc.....	Remainder

Manufacture.—4. (*a*) The material must be made from lake or electrolytic copper according to the I. A. S. B. specifications 2N2, and virgin spelter of A or B grade according to the I. A. S. B. specification 2N3.

(*b*) No scrap shall be used, except such as may accumulate at the manufacturer's plants from material of the same composition and of their own make.

Workmanship and Finish.—5. All bars are to be sound, straight, free from roaks, laps, cracks, twists, seams, and damaged ends, and are to have a workmanlike finish.

Physical Properties and Tests: *Tensile Test.*—6. (*a*) Rods from ¼ in. (6.35 mm.) to 1 in. (25.4 mm.) inclusive, shall have—

	Pounds per square inch.	Kilograms per square millimeter.	Per cent.
Minimum tensile strength	67,000	47.10	..
Minimum yield point..	45,000	31.64	..
Elongation in 2 inches (50.8 mm.).	..	....	22
Reduction of area.	..	....	45

Bending Test.—(*b*) The rods shall stand being bent, cold, through an angle of 180 deg. and to a radius equal to the diameter of the rod without fracture.

Strain Test.—(*c*) The rod shall stand an immersion in an aqueous solution containing 100 grams of mercurous nitrate and 13 cu. cm. of 1.42 specific gravity nitric acid per liter for 15 minutes without cracking.

Section of Test Specimens.—7. (*a*) Bars shall be grouped into lots of not more than 50. Three test pieces, one for each of the above tests, will be cut from a bar selected by the inspector from each lot or fraction thereof.

(*b*) The bending-test bar will be full size.

(*c*) The strain-test bar will be at least 12 in. (304.8 mm.) long, of full size, and shall be taken without bending, springing, polishing, or any other preparation whatever. At least 9 in. (228.6 mm.) of the length of this bar shall be immersed in the solution.

Dimensions and Tolerances.—8. Rods shall not vary in diameter more than the following amounts: Up to and including ⅜ in. (9.53 mm.), plus or minus 0.0015 in. (0.038 mm.); from ⅜ in. (9.53 mm.) to and including 1 in. (25.4 mm.), plus or minus 0.0030 in. (0.076 mm.).

Delivery, Packing, and Shipping.—9. (*a*) Rods and bars when ordered to any length will be furnished in stock lengths, unless it is specifically required that lengths be exact.

(*b*) Stock lengths will be as follows: When ordered in 12-ft. (3.66 m.) lengths, no lengths less than 8 ft. (2.44 m.); when ordered in 10-ft. (3.05 m.) lengths, no lengths less than 8 ft. (2.44 m.); when ordered in 8-ft. (2.44 m.) lengths, no lengths less than 6 ft. (1.83 m.); when ordered in 6-ft. (1.83 m.) lengths, no lengths less than 4 ft. (1.22 m.).

(*c*) When ordered to the lengths given above, the weight of lengths less than length ordered shall not exceed 40 per cent of any one shipment.

Digest of the Foreign Aeronautical Press

***Aeronautics* (London), Sept. 12, 1917**

Aircraft Losses in August.—The following are the official figures relative to aircraft losses in August:

German machines destroyed by British	129
German machines driven down by British	104
German machines destroyed by French	60
German machines driven down by French	22
German machines destroyed by Belgians	8
British machines missing	94
Allied machines claimed by Germany	168

In addition, a Zeppelin was destroyed in the North Sea off the coast of Jutland. It is to be noted that the French reports are incomplete, as on one day they claim the destruction of several German machines. Taking only definite figures, it appears that during August the Allies wholly destroyed at least 198 German machines on the Western front, while the enemy himself only claims to have accounted for 168 Allied airplanes.

***Aeronautics* (London), Sept. 19, 1917**

The Direct Lift Machine. By H. F. Smalman-Smith.—Assuming that a direct lift machine is today not merely mechanically possible, but capable of production in practical form, one may embody in brief some general idea of what would constitute a practical helicopter.

It would possess the ability to rise vertically from the ground and to descend thereto likewise. It must further be steerable and capable of horizontal motion at a moderate speed, at least. Its climbing capacity must equal or exceed that of the airplane; likewise, its ability to carry weight. Finally, it must include some reliable means of gliding down in safety in case of engine failure.

Given such a machine, it would appear to possess the following leading advantages: (1) It could rise from or descend to level areas little larger than that included in its circumference; (2) it could remain poised over a particular spot. In other things it would seem to be markedly inferior to the airplane.

Its application and value from the military point of view appear to be several. A helicopter might be made to serve every purpose achieved by a kite-balloon, while displaying the additional advantages of being independent of control from the ground, of being able to maneuver vertically or horizontally under its own power, and of presenting an infinitely smaller target. It would also require the services of a much smaller personnel and have the further advantage of being free from delays caused by inflation.

For patrol work its uses appear limited, although a helicopter might be employed as a night patrol machine in connection with the defense of cities or be used for reconnaissance work with armies operating in a rocky country where no airplane could rise or descend in safety.

In connection with naval operations, a helicopter might be used to advantage for observation purposes from aboard ship at times when the launching of a seaplane might be attended with considerable risk.

***Flight* (London), September 27, 1917**

Musical Sound of Aircraft Engines.—Some observers of enemy aircraft raids have pointed out that Gotha airplanes "drone" on the note A flat, while British machines prefer E and F. In doing so they have overlooked an important point when suggesting that anyone with the sense of absolute pitch should have no difficulty in identifying hostile raiders by their sound.

The pitch of a sound depends on the number of vibrations reaching the ear in a given time, and the number varies according as to whether the source of the sound is moving toward or away from the listener. Given a Gotha flying at 100 m.p.h., its A flat could vary as much as a perfect fourth, which is more than the difference between it and the British machines' E and F.

If an express train sounds its whistle while approaching and passing through a station, the pitch of the whistle, though actually the same all the time, will appear to rise as the train comes into the station and fall as it passes out. In the first case the sound waves reach the ear more frequently, as the source is approaching, and in the second less frequently as the source is retreating. It would be the same with Gotha's A flat, if it is always that note, whatever the speed of the machine, which is highly improbable.

***Flight* (London), October 4, 1917**

Germany and the Air.—At a recent meeting of the German Aerial League, the treasurer, Lieutenant Bothe, made a report which appears to represent quite accurately the views and beliefs of that very large section of the German people which thinks ahead and is convinced that air power will decide the future of empires.

He first gave a very clear and comprehensive survey of the present position of aeronautics in Germany, claiming that the Germans had now really obtained the supremacy of the air on the Western Front as on other fronts, though he had to acknowledge that at the time of the great Somme offensive the mastery in the air belonged to the British and French.

ALBATROS D. III FIGHTERS

Pictorial Press *British Official Photograph*

This led to a reawakening in German military circles and to a redoubling of their efforts to regain that supremacy, and no stones were left unturned until that object had been successfully attained.

The Germans had now left their adversaries far behind, both in the number and quality of the aircraft being turned out, as the English were learning to their cost.

Lieutenant Bothe then dealt at some length with the position of military aeronautics after the present war. He foretold that on the cessation of the present hostilities all the nations would at once proceed to build up an impenetrable series of modern defensive works, extending several miles behind their frontiers, and which it would be beyond the power of human beings to break through, except by the aerial arm.

In future wars it would be necessary to invade the enemy's territories by means of tens of thousands of airplanes, which by dropping hundreds of tons of explosives would destroy all industrial works, transport routes, etc., and thus delay the advance of the troops and impede preparations for offence or defence.

The war would be won within the first few days of the declaration of hostilities by the Power or Powers which were thus able to throw in the largest weight of aerial "frightfulness" and thereby paralyze the fighting efficiency of its opponents, before even a battle had been fought or a campaign opened.

Where, it may be asked, are to be found the pilots to man these tens of thousands of airplanes? This would be one of the chief duties of the German Aerial League, an institution which was daily growing in importance and influence.

By suitable courses of training at airdromes and in the workshops, the youth of the country would be prepared for later service in the Flying Corps.

Air Raid Precautions.—The Police Commissioner of London has issued, for the guidance of the public, a set of rules to be observed in case of a hostile aircraft raid. In view of the possibility of Germany developing submersible seaplane carriers from which American shores might be bombed, it seems interesting to review here these rules.

Do not pay heed to mere rumors of a raid, but as soon as you know, whether from a public warning or from the anti-aircraft guns coming into action, or from the explosion of bombs, that an attack is imminent or has begun, take the best cover near at hand.

Do not wait till you see the aircraft nearly overhead or hear the explosion of a bomb near you. You cannot tell how near the next bomb may fall, especially at night, and apart from the danger from bombs, fragments of shells may fall a long way from the guns. To stay in the open involves needless risk, even if the attack seems a long way off.

If you are in the open, go into the nearest available building. A doorway or open archway, though better than remaining in the open, is not good cover, as it affords little protection against fragments of a bomb exploding on the ground.

If bombs are being dropped and there is no building near, it is better to lie down on the ground in the best ditch or hole you can find near at hand, or behind a strong wall or tree, than to remain standing in the open.

If you are in a building on the top floor, go downstairs, where you will have the best available cover overhead, avoiding elevator openings, open stairways and parts of the building under skylights.

Do not look out of windows, but keep in a part of a room or passage where you will be out of the line of fragments of metal or debris, which may enter by a window or door if a bomb should explode outside.

Do not crowd in a basement with only a single means of exit. The fumes from all bombs are injurious if breathed in any quantity, and it is advisable to have a second means of exit in case fumes should enter, or a gas pipe be broken, or rapid escape be necessary for any other reason.

Water is far the best extinguisher for general use against fires caused by incendiary bombs, and should be applied as promptly as possible. Keep a supply of water ready in buckets or cans, some on each floor, if possible. See that they are kept filled.

A supply of fine dry sand or soil may be kept ready in pails or scuttles, in addition to water, especially where there are inflammable liquids which might be set alight. See that the sand or soil does not cake.

If the gas is turned off at the meter, see that all burners are turned off as well; otherwise there will be serious risk of fire or explosion when the gas is turned on again.

Be careful not to breathe fumes given off by bombs. Do not go near where any bomb has fallen unless it is necessary to do so for rescue purposes or to extinguish a fire, or unless you are sure all fumes have cleared away.

If a bomb falls near you, get away from the place where it has fallen as quickly as possible, and keep away until the air has cleared. If you are indoors and fumes have entered the building, go out into the open away from where the bomb has fallen, and if the raid is not over, find other shelter.

While good cover is the point of most importance, choose, if you can, rooms, corridors, etc., where in addition to cover overhead there are alternative means of exit, so that if fumes should enter from one direction you may be able to escape the other way.

Flying (London), September 26, 1917

Aero Engine Fuels.—The ideal fuel for internal combustion engines would be one having an entirely homogeneous composition with a constant boiling point and unvarying density at that boiling point; but gasoline does not attain this perfection, for when subjected to a gradual increasing temperature the fuel steadily loses in volume and increases in specific gravity until the temperature corresponding to the boiling point of its heaviest part is attained when it is completely evaporated.

The supply of gasoline has now assumed a position of great importance in all countries. It is essential for the commercial future of the airplane that there shall be a plentiful supply of this fuel at reasonable prices, and it is generally recognized that the enormously increased demand can only be met by either a greater production or by increasing the specific gravity of the gasoline in order to obtain a greater proportion from the crude oils when refining. It is quite possible that by the latter method double the present available supply may be obtained if the maximum boiling point of the fuel can be increased to over 200 deg.; but this can only follow such improvements in the design of aero engines as will allow of a heavy fuel being used. It is doubtful whether the production of the present grades of gasoline from existing or new wells can be increased to an appreciable extent, and it has been suggested that this supply can be augmented by condensing the natural gas obtained at the oil fields. It has, however, been shown that even if this were done in all parts of the world, the total yield of gasoline would only be about five per cent more.

Various substitutes for gasoline have been proposed during the past few years, and probably benzol is the best known of these, as before the war it was becoming extensively used for motor-cars.

Benzol is not a definite compound, as it is a mixture of the hydro-carbons benzine, toluene, and zylene, each of which can be obtained pure, so that the commercial fuel is more homogeneous than ordinary gasoline. The specific gravity of crude benzol is approximately 0.9, and that of the commercial fuel supplied for engines about 0.88.

Benzol is a very inflammable oil, and the vaporization point occurs just a little later than that of the heavier grades of gasoline, but its range is much narrower; also from comparative tests with this fuel and gasoline with motor-cars it has been found that an increased mileage is obtained per gallon, although the calorific value of benzol is only 17,250 British thermal units per pound. The greater density is due to the oil being rich in carbon and containing a lesser amount of hydrogen, and this high percentage of carbon makes it especially suitable for mixing with another gasoline substitute, alcohol, the resulting mixture forming a most suitable home-produced fuel for motor-cars and air engines, which could ultimately be obtained in sufficient quantity to make this country independent of gasoline.

A gasoline carburetor can be used in the ordinary way for carbureting air with benzol, but the carburetor jet has to be corrected in height or the float adjusted to allow the heavier fuel to stand at the correct level in the jet, and a slightly better supply of air is required owing to the fuel containing more carbon. The grade of this fuel suitable for engines is usually known as "90 per cent Benzol," so called because this percentage will distil out at a temperature below the boiling point of water.

Flying (London), October 17, 1917

Aeronautical Terminology.—A representative committee of the Aeronautical Society of Great Britain is now taking in hand the putting into shape of the technical terminology of aeronautics. The work being of considerable magnitude, the full results of the labors of the committee will not appear for many months, but it is understood that certain preliminary definitions will be dealt with quickly in order to clear the ground and relieve existing anomalies that cause confusion. (This work will undoubtedly prove a valuable addition to the elementary terminology the Aeronautical Society published shortly before the outbreak of the war. The terms adopted therein are now used in most English and American textbooks.—EDITOR).

Air Work in September.—The accompanying comparative table shows the total number of airplanes and seaplanes brought or driven down on the Western front during five months:

May	717
June	713
July	467
August	400
September	704

Out of the total for September, the Allies, according to German claims, lost 242 machines and the Germans lost 462. The detailed reports for September are:

BRITISH REPORTS	
Enemy machines brought down	148
Enemy machines driven down	142
British machines missing	112
FRENCH REPORTS	
Enemy machines brought down	91
Enemy machines driven down	79
Enemy balloons brought down	3
GERMAN REPORTS	
Allied machines brought down	242
German machines admittedly lost	3
Allied balloons brought down	8

News of the Fortnight

Aircraft Board Appointments

Naval and military members of the Aircraft Board, about to be reorganized under a law giving it legal status, were announced on Oct. 26 by Secretaries Daniels and Baker. President Wilson is to name a civilian chairman and two other civilian members.

All of the service representatives appointed except. Lieut. Commander Arthur K. Atkins, of the Navy, are members of the present board. They are: Navy, Rear Admiral David W. Taylor and Capt. H. E. Irwin; Army, Maj. Gen. George O. Squier, Col. E. A. Deeds and Col. R. L. Montgomery.

Powerful Airplanes Are Planned

The day of thrilling air duels between individual aviators over the fighting lines in Europe appears to be passing. Both official and unofficial advices recently have shown increasing use of heavier machines with greater armament, and the development of air machines appears to be paralleling closely the development of fighting ships.

There are indications that amendment already has been necessary in the program for creating the huge air fleets provided for by Congress. While there will be no lack of small fighting airplanes, it is probable that stress is being laid now on the bombing craft and upon increasing the speed of these heavier machines and giving them adequate armament. Already plans are maturing for powerful airplanes, it is understood.

There have been rumors of great German aircraft soon to make their appearance, and officials believe that the Germans are impressed with the desirability of substituting heavier machines in which fighting power takes the place of speed.

The production of training machines, it is understood, is the only element of the aircraft program which is lagging behind schedule.

New supply sources for the training machines are shortly to begin deliveries. That will increase the output, and the first of the year probably will see the entire program abreast or ahead of its schedule. In the meantime there has been little delay in the training of aviators and many already have been sent abroad after preliminary instruction to get proper flying experience.

Orville Wright Honored

Orville Wright was honored on Oct. 27 by Lord Northcliffe, head of the British War Commission to the United States, who decorated him with the Royal Albert Medal. The medal was presented by the Royal Society of the Arts of England, which awards a medal each year to some one prominent in the arts and sciences of the world.

New Balloon Altitude Record

According to the geographical institute at Pavia, Italy, the highest altitude so far reached by any balloon was 105,000 ft., or slightly over eighteen miles above sea level; and 104,082 ft. above actual ground. The balloon was of rubber and was filled with hydrogen gas.

The actual distance traversed measured 116,064 ft. At a height of 59,196 ft. the temperature fell to minus 43 deg. and maintained that figure all the balance of the way up, with only slight variation.

The aviator, Giacomo Piccolo, was compelled to utilize his oxygen inhalator after he reached the height of two miles, and reached ground in a collapsed condition nevertheless.

Prof. Pericles Gambia, in the Annali di Ufficio, states that the benefits to science from that ascent were incalculable, as it proved mainly two things: that the assumption of a fifteen-mile atmosphere above the ground is erroneous, and that the theory of ether outside of that limit is not admissible, "if it does not altogether do away with the ether theory at any height." The word "ether" has been formed to express the medium for light beyond the assumed atmosphere.

This ascent established beyond peradventure that the medium is uniform after the height of about 50,000 ft. was reached. If the atmospheric consistency remains the same 55,000 ft. after that altitude, the assumption that it will remain the same further up reaches the dignity of a presumption.

To Make a Pictorial History of War

The Photograph Division of the Signal Corps has been formally designated as the bureau which will obtain the necessary photographs to form a pictorial history of the "War of 1917," as the present conflict is specifically termed in the orders relating to this new venture. The detail of commissioned officers and men to handle the photographic work is authorized from each division. These men will be attached to the Signal Corps units assigned to the army division. Regimental and separate organization commanders have been instructed to submit the names of men, qualified to fill the above positions, who desire to be transferred to the Signal Corps.

An Airplane Material Course

Training students as inspectors of airplane material is the latest war-time addition to the curriculum of the Pennsylvania State College. Prof. George R. Green, of the Department of Forestry, has started a class of twenty men in wood technology. They will study the structure, strength and durability of spruce and ash, which are the chief woods used in airplane construction.

Pictorial Press

NIEUPORT 1½ PLANE FIGHTER

French Official Photograph

British Airplane Representative in America

Basil Bancroft
Photo Moody

Basil Bancroft, American representative of Whitehead Aircraft, Ltd., Richmond, Surrey, England, recently arrived in America with plans for cooperating with the American airplane manufacturers in the assembly of American machines in the Whitehead works.

Both Mr. Bancroft and J. A. Whitehead, governing director of the company are native Californians. Mr. Bancroft served in the British Army in France and has been honorably discharged because of wounds and shell shock.

Whitehead Aircraft, Ltd., is one of the largest British manufacturers, is capitalized at over $6,000,000.

They have been engaged exclusively in turning out and have nearly completed an additional plant for enlarged production of fighting machines for the British Government.

Airplane Engine Endurance Record

For the first time in the history of the aeronautical testing laboratory at the Washington Navy Yard an airplane engine has completed the Government endurance test. When it is considered that engines from all parts of the world have been tested at this laboratory previously, and that not a single one of them has run over 36 hr., the severity of the test is better appreciated.

As in the case of the two previous records, the new high mark has been set by an American-made engine, one built by a concern which has until recently been known only in the field of heavy duty marine engines. The experience gained in many years devoted to the design of engines, in which reliability and endurance were of the greatest importance, has evidently had much to do with the success of this new engine.

The record run as it now stands is 54 hr., and was made by the Union engine. In fact, it was established by the same engine, which last May was put through a similar test by Government inspectors at San Francisco, a complete description of which was published in Aviation and Aeronautical Engineering, July 1, 1917.

Although details of the test are not now available for publication, it is understood that the engine was intentionally stopped after running 54 hr., owing to the blowing out of an oil pump gasket, which, due to consequent low oil pressure, made it unwise to continue the test, although the engine was otherwise in perfect condition and still delivering over its rated power.

The Caproni Machine Flies to Mineola

What is reported to be a new record in long distance passenger carrying flights was made Oct. 22 by Lieutenant Resnati, the Italian aviator who flew from Langley Field, Hampton, Va., to the U. S. Aviation Field at Mineola, N. Y., in a little over four hours. The Caproni biplane made the 325-mile run without a mishap. It was preceded by a Pomilio biplane scout driven by Lieutenant Baldioli, who made the trip with one passenger in a little less than three hours.

The passengers in the Caproni were Capt. A. W. Hill, C. A. C.; Lieut. M. W. Pollack, who represented Maj.-Gen. Geo. O. Squier, Chief Signal Officer of the Army; Capt. Carlo Tappi of the Italian Aviation Commission; Lieut. A. Camponi; Corp. J. Z. Angelo and Giovanni Bosso; and Francesco Callutti, mechanician, and Lieut. James Erickson, the American photographer.

Wood Experts Sought

The War Department has asked the University of California to assist in selecting a number of experts in woods, according to an announcement made recently by university authorities. These experts will receive salaries ranging from $1,200 to $3,000 yearly, and must be skilled in the picking out of woods suitable for military airplanes.

More Aviator Cadets Wanted

Efforts are being made at the headquarters of the Eastern Department to speed up the rate of enlistments in the Aviation Section of the Signal Officers' Reserve Corps. Twenty thousand men are needed to man the great air fleet which the War Department intends to send to Europe. Although the Aviation Section attracts many applicants before the examining board each day, the physical and mental requirements are exacting and fully 50 per cent of the applicants received are rejected.

An official in charge of recruiting for the Aviation Section denies that candidates are subjected to any nerve-racking tests, as has been frequently reported. He says the examination is a scientific one, calculated solely to ascertain the applicant's physical condition and his powers of endurance. Absolutely perfect eyesight is required. In all other respects, however, the examination is one which any man can pass, provided he meets the requirements as to height and weight.

Candidates for commissions as flying officers in the Aviation Section must be at least nineteen years old and preferably not more than thirty, although in exceptional cases older men of pronounced athletic attainments, who have spent most of their lives out of doors, in the saddle, ranching, etc., may be accepted if they can satisfy the examining board of their physical fitness. Candidates for commissions must have college training or its equivalent. Applicants will not be recommended, who are not in every way qualified and fitted to become officers of the United States Army.

All candidates are enlisted in the Signal Corps or the Signal Enlisted Reserve Corps. This service will actually hold them for the period of training, which covers the course at the schools of military aeronautics (ground schools), and at the aviation or flying school up to the time when, having passed the tests for a reserve military aviator or junior military aviator as required by the Chief Signal Officer, they are commissioned. If they fail, they will be discharged from the Signal Corps and revert to their former status. Failure to qualify for a commission will not exempt from the draft law.

Army Wants Air Mechanics

The Aeronautical Office of the United States Army at 104 Broad Street, New York City, has made an appeal for recruits to go to France immediately as privates in the Aviation Section of the Signal Corps to maintain and repair airplanes.

Maj.-Gen. George O. Squier, Chief Signal Officer of the United States Army, has directed that a recruiting campaign begin at once, with the object of enlisting a total of 100,000 men who will be employed chiefly at the hangars of American aviators in keeping flying equipment in shape. The men called for in this appeal are not to act as aviators, but will remain in barracks at the aviation fields which are occupied by Americans in France. Those who are first to enlist as privates in the Aviation Section will go to France.

Carpenters, electricians, mechanics, men familiar with gas engines, and others who know how to use their hands are asked to enlist at once.

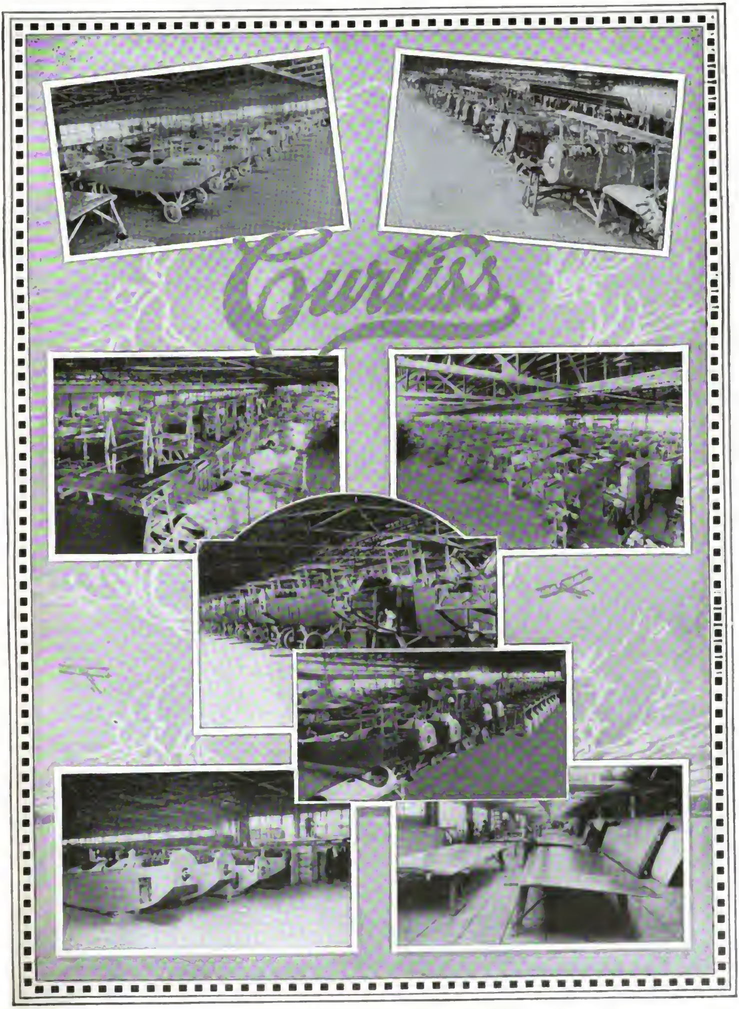
British Aeronautical Material Agent

It is reported that Arthur F. Thane of A. F. Thane & Co., San Francisco, Cal., has been appointed purchasing agent for the British Government on the Coast for all lumber, aeronautical material and supplies, which will be drawn from that region for aircraft construction and equipment.

In addition to acting as purchasing agent, Mr. Thane will have charge of all shipping for the British Government on the Pacific Coast. For ten years he was connected with W. R. Grace & Co. of New York.

New Training Biplane

A new type of training biplane has been flown at Central Park, N. Y., by Army Instructor Acosta, in which the instructor and pilot sit side by side. This arrangement, it is believed, will shorten the time required for training aviators. The machine is the product of the Ordnance Engineering Co., and is powered with a 100-hp. Duesenberg engine.



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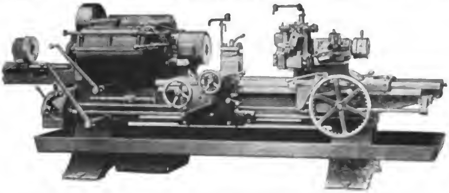

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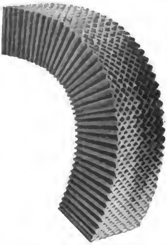

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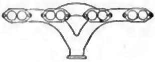

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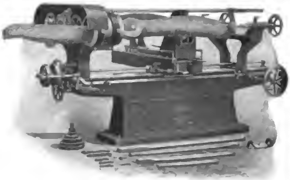

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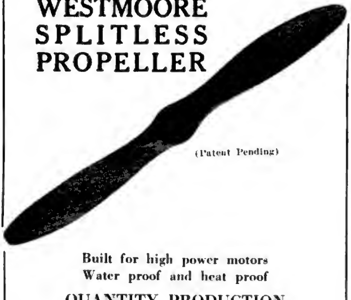

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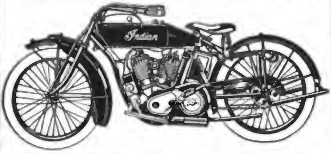

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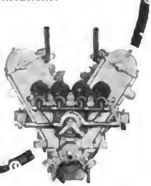

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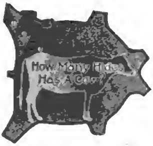
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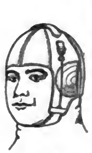

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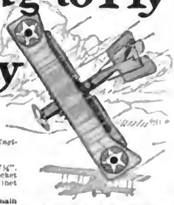

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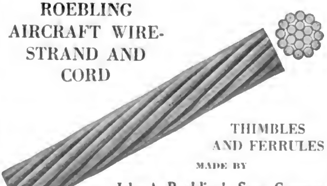

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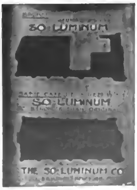

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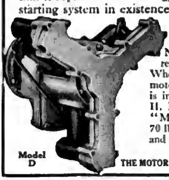

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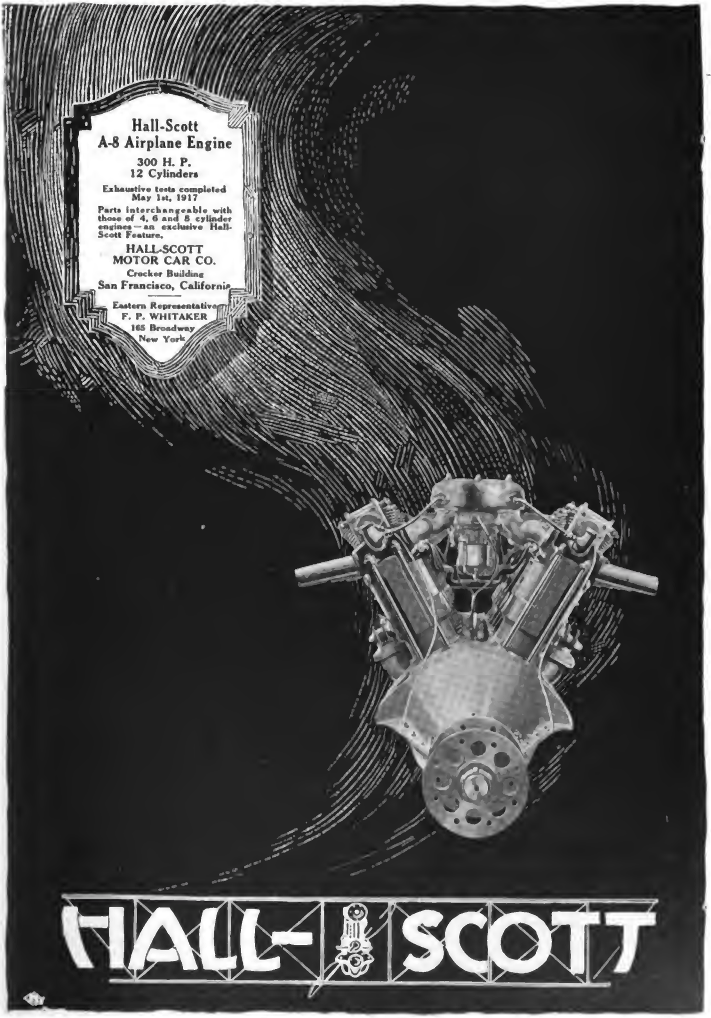

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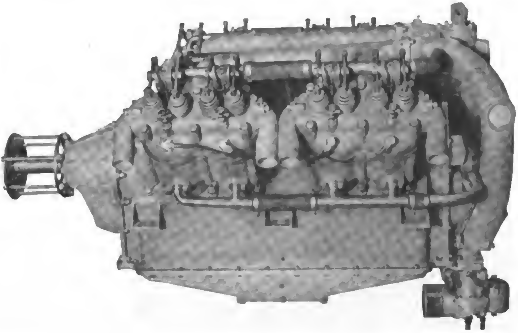

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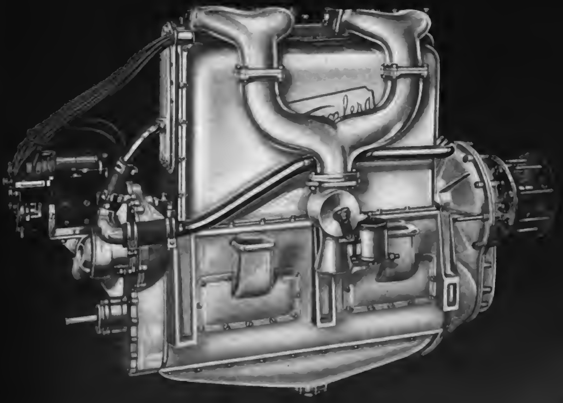

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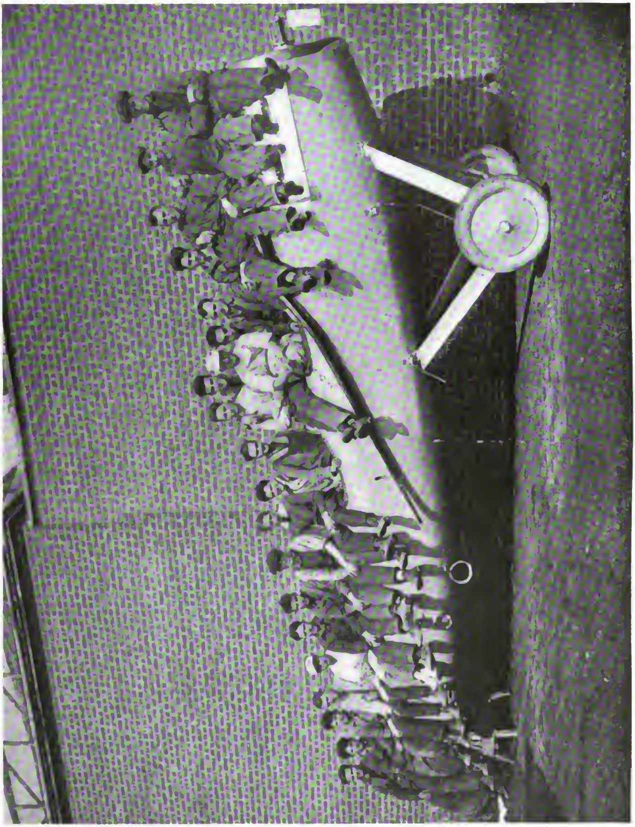

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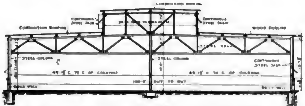

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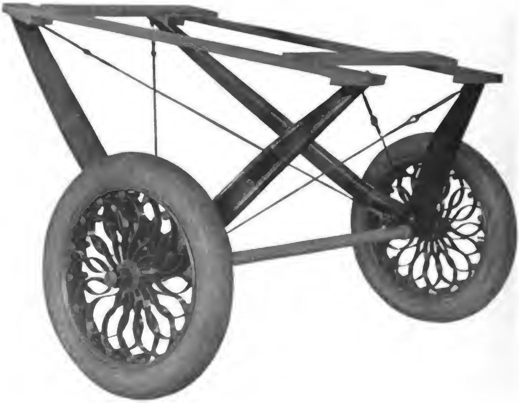

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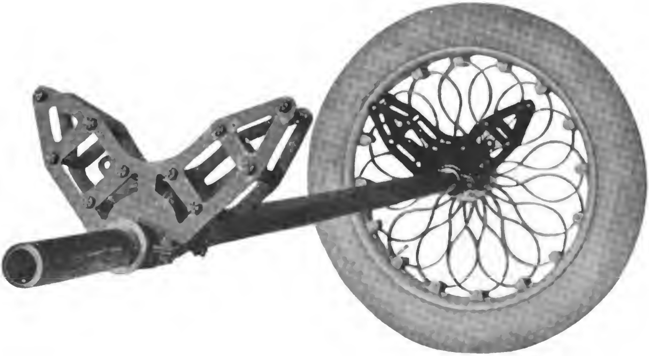

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AVIATION
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Vol. III November 15, 1917 No. 8

Langley's Flying Machine

By Carl H. Butman

Late of the Smithsonian Institution

The Langley "aerodrome," the first man-carrying airplane ever built, is now exhibited by the Smithsonian Institution in the older building of the United States National Museum at Washington, D. C., as a very valuable historical relic.

SAMUEL PIERPONT LANGLEY
After a Painting by Carl Smith

Samuel Pierpont Langley, the inventor of the flying machine, has been long in coming into his own, but at last his name has come to stand for the pioneer in aviation.

According to Dr. A. F. Zahm, aeronautical expert, United States Navy, Langley's "aerodynamic experiments, some published and some as yet unpublished, were complete enough to form a basis for practical pioneer aviation. He built and launched, in 1896, the first steam model airplane capable of prolonged free flight, and possessing good inherent stability; he built the first internal-combustion engine suitable for a practical man-carrying airplane; he developed and successfully launched the first gasoline model airplane capable of sustained free flight, and he developed and built the first man-carrying airplane capable of sustained free flight."

At the Panama-Pacific International Exposition there was erected a great column dedicated to Progress, representing, in that connection, Aviation. It bore the following inscription: "To commemorate science's gift of Aviation to the world through Samuel Pierpont Langley, an American."

To the memory of Langley, late Secretary of the Smithsonian Institution, the civilized world finally bared its head nearly ten years after his death. His man-carrying "aerodrome," built in 1900-03, was flown in 1914, thereby vindicating the claims Langley advanced; first in 1896, when he flew his steam model successfully, and supplemented in 1903, when his gasoline model flew, although his two attempts to launch the large machine in the latter year failed. It has since been established that this machine will fly under its own power as originally designed and built, and even carry additional weight.

The original machine, surnamed the "Buzzard" was returned to its birthplace, the Smithsonian, in March, 1904, after the conclusion of the experiments, and there stored for ten years. On April 2, 1914, it was shipped to the Curtiss factory at Hammondsport, N. Y., for reassembling and tests. Dr. Charles D. Walcott, Secretary of the Smithsonian Institution, and Dr. Albert F. Zahm, Recorder of the Langley Aerodynamical Laboratory, and now a Naval aeronautical expert, were present and witnessed the first flight. This experiment was primarily an engine and planing test, although the machine was mounted on pontoons for an over-water flight. Great, therefore, was the surprise of those present when after running over the surface of the water for a short distance, the machine lifted itself into the air and proceeded to fly.

Considerable publicity was given this and later trials by the press, but as many of the newspaper articles were unfortunately vague, and even inaccurate, it was hitherto difficult to ascertain just exactly what had been accomplished. It has been the purpose of the writer, however, to look into the matter very carefully and consult witnesses and authorities. The story in brief follows:

Upon the receipt of the complete flying machine at Hammondsport, it was reassembled. Few changes were made, since it was desired to fly it in its original form if possible. First the engine was put through a shop test, which showed the necessity of replacing the old intake manifold pipe and of adding a new carbureter. It also proved expedient to install a magneto in place of the original batteries used for sparking. There being a spare pair of propellers, they were cut down on the corners much after the fashion of the early Wright-type blades, but as this did not increase the efficiency, Mr. Langley's original fan-type set was used.

The first trials with the floats, which consisted of two shallow draft pontoons forward and a float aft, proved that the machine would plane very well with the original wings. Then followed on May 28, 1914 a demonstration of the complete machine, which well proved the efficiency of the engine. This, the original power plant, not only drove the machine over the water, but lifted it out completely and started on a flight in

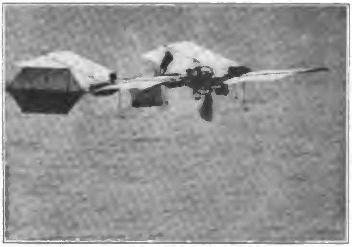
---

NOTE.—The name "aerodrome" was given by the late Samuel Pierpont Langley to the flying machine in 1893, from ἀεροδρομέω (to traverse the air) and ἀεροδρόμος (air runner).

spite of the additional dead weight of the pontoons, a weight never anticipated by the inventor.

Dr. Walcott, who was fortunate in observing this test, made the following statement to the writer:

"Early in the morning of May 28 the machine was launched with its pontoons and Glenn H. Curtiss climbed into the aviator's seat. Starting the propellers, the machine glided over the water for 200 or 300 yd., bringing the pontoons so that they planed over the surface. It then rose in the air a short distance and continued for about 200 ft. when Mr. Curtiss brought it back to the water.



Quarter Size Model of the "Aerodrome" in Flight, Aug. 8, 1903

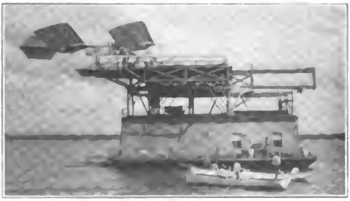
Photo Smithsonian Institution

"Several trials were made subsequently, but owing to engine trouble and the giving way of certain of the old ball bearings between the engine and the propellers, the pontoons did not get out of the water.

"It was decided to strengthen all bearings so that the strain between the engine and the propellers, resulting from the weight of the pontoons and supports, would be provided for.

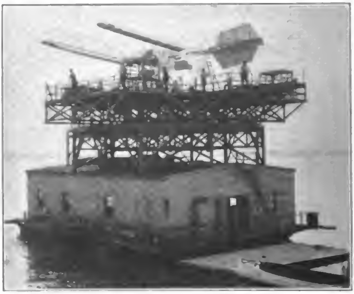
"The several trials proved great stability for the tandem type of machine. As the result of experience with biplanes and monoplanes during the past ten years, another tandem machine, if built, would have a very much smaller wing surface and would be provided with an engine of greater power and efficiency."

Soon after the first flight, some readjustments were made on the machine and further tests were conducted on June 2, with far better results, although no lengthy flights were made, for it was thought best not to over-tax and possibly destroy the engine, bearings and shafting. The added weight of the pontoons and their supports increased the weight of the whole machine from 830 lb. to 1,170 lb., or 40 per cent, an amount too great for safety and efficiency. In the hope of offsetting this additional weight, Dr. Walcott agreed that a Curtiss 80 hp. engine with a single-tractor screw be fitted since its line of thrust is practically identical with that of the Langley twin propellers. On installing this power plant, the aviator's seat was moved up and backward between the planes, and other minor adjustments were made.



Full Size Langley "Aerodrome" Ready for Launching, Oct. 7, 1903, on Potomac River, Near Widewater, Va.

Photo Smithsonian Institution

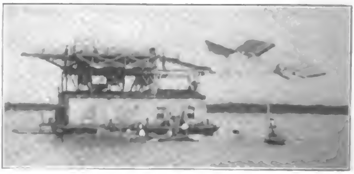


Three-quarters Rear View of Large Machine Resting on House-Boat. Turntable for Pointing the Nose of Machine Into the Wind is Shown Below the Platform

Photo Smithsonian Institution

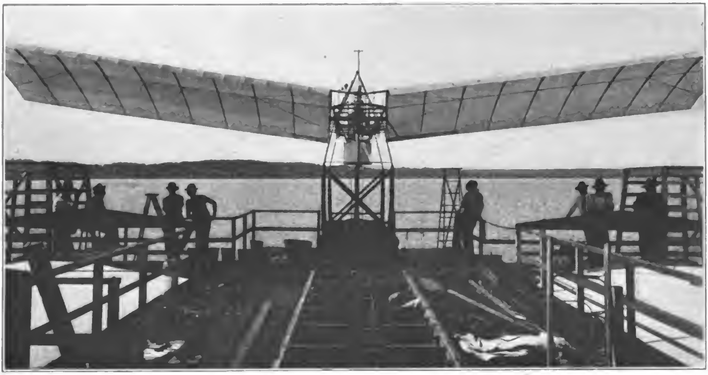
On Sept. 17 two flights were made by Elwood Doherty. The complete machine now weighed 1,520 lb., but no bending or warping of the wing frame was noticed in spite of an excess of 83 per cent over the originally designed load.

On Sept. 19, after some additional adjustments had been made in balancing, and in the angle of incidence of the wings, and substituting a 9-ft., for an $8\frac{1}{2}$-ft. air screw, more successful flights were made between 1,000 and 3,000 ft. in length. Work on the "America" delayed further tests for awhile, but on Oct. 1, six flights were made, covering distances of from 1,000 to 3,250 ft. at a speed of about 35 m.p.h. Mr. Doherty, who piloted the machine, stated that the inherent stability was excellent and that the control was satisfactory, although merely the universal tail was used for stabilizing. Subsequently longer flights were achieved, and some of these were made when winter having set in, the machine was equipped with skates and flown from the ice. It was not flown high in the air, for fear of some accident, since it was felt that it had vindicated itself and deserved to be exhibited as the pioneer American machine.



First Trial Flight of the Langley "Aerodrome" from House-Boat, Oct. 7, 1903. In Falling, the Front Part of Track Caught the Front Guy-Post and Bent it Backward, Pulling the Front of the Machine Down, as Shown. The Two Lower Guy-Posts Should Be Parallel

Photo Smithsonian Institution



FRONT VIEW OF LARGE LANGLEY MACHINE ON LAUNCHING WAYS IN 1903
Photo Smithsonian Institution

Langley's "aerodrome," which was completed in 1903, eleven years before it took to the air proved within the limits of its trial flights to be as stable as our modern airplanes. When it is considered that this machine was built at an epoch when the art of metallurgy was not far advanced, one cannot but note with admiration how well the structural steel and the bearing surfaces stood up under tests which far exceeded the requirements for which Mr. Langley had allowed.

The Langley-type machine is known as a tandem monoplane; its frame in plane view is an elongated ellipse of steel tubing, built, guyed and balanced with the greatest scientific accuracy. The four wings, set at dihedral angles for inherent stability, were built up of especially designed hollow ribs of wood, patterned after the quills of a bird, and covered with percaline. Its power was derived from a five cylinder, water-cooled gasoline engine, which developed over 50 hp. at about 950 r.p.m., and operated the two propellers from a main shaft by bevel gears. The propellers were made of crossed steel tubes covered with cloth. The cruciform tail, the sole means of control, was of the Pénaud type, arranged for automatic balance, yet sensitive to regulation by the pilot. The total wing area was 1,040 sq. ft. and the weight was 830 lb.—about one-and-one-quarter square feet to the pound—giving a much lower lift loading ratio than is employed today where high-speed motors are used. Nevertheless, this ratio enabled Mr. Curtiss to fly the machine with about 340 lb. overload.

DR. S. P. LANGLEY ON RIGHT AND CHARLES M. MANLY ON LEFT
Photo Smithsonian Institution

In 1903 the only apparent fault with the experiments lay in the launching apparatus. The method employed comprised a car running on a 60 ft. track, propelled by a catapult arrangement of springs, which with the added thrust of the propellers was calculated to give the "aerodrome" sufficient momentum to start its flight from the top of the house boat.

VIEW OF THE MACHINE TAKEN AT HAMMONDSPORT IN 1914
Photo Curtiss Aeroplane Co.

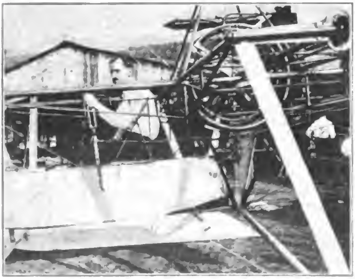
On the only two occasions when this machine was tested, Oct. 7, and Dec. 8, 1903, this apparatus unfortunately failed to operate properly and the machine fell into the water. It never had an opportunity to prove its worth. On the first trial two clips, which held the forward guy-post of the machine to the launching car, failed to release at the end of the run, and consequently the forward end was dragged downward

Assembling the Langley Machine at Hammondsport
Photo Curtiss Aeroplane Co.

when the fore part of the track dropped away for clearance. This can be seen in the photograph of the first launching, wherein the forward post is seen to be bent backward, out of alignment with the after post.

Two months later, during the second trial, the bolts holding the rear guy-wires gave way, due to too great an initial impulse, allowing the rudder to drag and catch as the machine started to leave the track. This pulled the rear of the "aerodrome" down so that the combined forces of thrust and drag made it turn a backward somersault in the water.

Although Mr. Langley considered nearly every form of launching device, including the track, pontoon, and catapult methods, he was determined to make safety the greatest factor, and therefore launched the machine from the house boat over the water, where, if it should fall, the danger of damage to the aviator and the machine would be as small as possible. The system unfortunately did not prove efficient, but it was evolved eleven years ago, and we can all recall the difficulties encountered by the Wright brothers in their early launchings. Had they been discouraged after two attempts nothing would have ever come from their efforts, but being their own masters and not responsible to the Government as Mr. Langley was, they were enabled to persist in their efforts until success crowned their work.

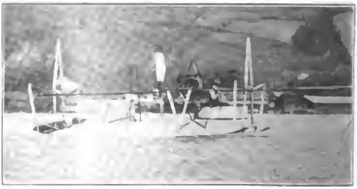


Glenn H. Curtiss Seated in the "Aerodrome"
Photo Dr. Charles D. Walcott

Charles M. Manly, who designed the gasoline engine for the Langley machine and assisted Mr. Langley in his research work, also chose to fly the "aerodrome." Despite the fact that the machine lacked a proper landing gear or even shock absorbers of any form, Mr. Manly bravely mounted into the airplane resting on the top of the house boat, and after testing his controls, waved his hand, signalling that he was ready. The propellers began to whirl faster and faster; the great catapult springs were released and down the track sped the machine only to be upset and to drop with the aviator into the Potomac River. Twice did Mr. Manly attempt to fly, with the same results, and each time he extricated himself with difficulty from the sinking machine.

The "Aerodrome" as Converted into a Seaplane, May 28, 1914
Photo Dr. Charles D. Walcott

Mr. Langley's interest in aeronautics was manifested first in 1887 when he undertook to demonstrate the possibilities of and the conditions for transporting in the air a body heavier than air. His experiments led from elementary tests with toy airplanes of rubber-band propulsion to tests of single planes and superposed planes, rudders, propellers and other apparatus by the plane-dropper, pendulum, and the whirling



Skimming Over the Water Without Wings
Photo Curtiss Aeroplane Co.

table, to steam and gasoline power-plants and model aircraft propelled by them.

Success in actual flights first attended his efforts on May 6, 1896, when one of his model steam "aerodromes" made two flights at Quantico, Va. Dr. Alexander Graham Bell, who was present at this first flight of a heavier-than-air machine, said at the time: "No one who was present on this interesting occasion could have failed to recognize that the practicability of mechanical flight had been demonstrated."

THE "AERODROME" IN FULL FLIGHT OVER LAKE KEUKA
Photo Weyman

Other flights of steam models followed upon the first, and on Nov. 28, 1896, a remarkable flight was witnessed by F. G. Carpenter, a prominent newspaper man, who reported it to the press. In 1898, President McKinley requested Mr. Langley, through the War Department, to build a man-carrying machine, and in spite of Langley's previous statement, "I have brought to a close the portion of the work which seemed to be specially mine, the demonstration of the practicability of mechanical flight," he willingly undertook the task which the head of the Nation asked him to shoulder.

THE "AERODROME" FLIES, SEPT. 17, 1914, WITH CURTISS ENGINE AND TRACTOR, SEAT MOVED UP AND BACK
Photo Weyman

One more achievement was his, before the trials of the large machine; and that was the successful flight of the quarter-size air-cooled gasoline model which flew unguided and without mishap on Aug. 8, 1903.

Following the two attempts to launch the man-carrying machine, mentioned above, there came such a flood of ridicule from both the press and the public, that the War Department made no further allotment, but discontinued the trials and turned the machine over to the Smithsonian Institution.

It has frequently been said that Mr. Langley died of a broken heart, and while this is held by some to be inserted for an added romantic interest, many of the Smithsonian officials and others closely connected with Mr. Langley's interests, feel that the unjust criticism of which he became a recipient did much to hasten his end in 1906, three years after his last aeronautical experiments were concluded. It is only natural that he should have keenly felt the lack of public foresight on the problems which he had mathematically and scientifically proved, but failed to demonstrate practically.

THE COLUMN OF PROGRESS BEARING LANGLEY'S NAME
Photo Smithsonian Institution

Balsa Wood

The United States Forest Products Laboratory has recently conducted a number of tests with Balsa wood to determine its general characteristics.

Some of the results of these tests are now available and are published in the accompanying table.

Piece number	Moisture content based on dry weight of wood	Specific gravity based on the air-dry volume	Compression parallel to grain	Hardness
			Maximum crushing strength	Load required to imbed a 0.444 inch ball to one-half its diameter
	Per Cent		Lbs. per sq. in.	Pounds
1	612.0	.104	507	78
2	400.0	.122	780	138
Average	506.0	.113	643	108
3	3.6	.118	1570	75
4	3.7	.100	1170	66
5	4.2	.094	930	68
Average	3.8	.104	1220	70

Note.—Specimens 1 and 2 were soaked until saturated throughout, before being tested. Specimens 3, 4, and 5 were tested dry.

Airplane Stays

By Harry A. Whitney

From accidents due to the collapsing of a wing, or the wings, of the airplane, it is evident that, in some cases, the wire stays are not equal to the strain put upon them. The reasons for the deterioration of a wire, or strand, suggest improvements, experiments, and tests, which it is hoped may aid airplane constructors in their search for a better stay.

Paradoxical as it may seem, wires of the highest strength are not the best to withstand the sudden strains and constant vibration to which stays are subjected on airplanes. The essential qualities of a durable and reliable stay wire, or stay strand, are strength, combined with toughness and elasticity. In addition, all parts of the stay should be protected from rust. It is important that these qualities should be retained, as far as possible, during the life of the airplane.

Using a 3/16 in. solid wire which has a strength of 5000 lb., the finished stay may have a strength of 5100 lb., a loss of 400 lb. In the same way, a wire strand that tests at 4600 lb. makes a stay having a strength of 4100 lb.

Assuming that the turnbuckles employed very properly equal the strength of the stay wire or stay strand used in making the stay, naturally the fastenings of the wire or stay strand are weak points in the completed stay.

At the fastenings, the wire or strand is necessarily subjected to a severe bending stress around the turnbuckle-eye and eye-bolt, which bending not only reduces the strength of the stay wire or strand, but causes the tin or galvanizing to crack and peel from the wires. The wires thus exposed, unless painted frequently, are soon attacked by rust from the moisture which collects on the stays.

A light round thimble, the groove of which conforms to the exact size of the stay strand, should be inserted in the turnbuckle-eye and eye-bolt. This thimble prevents abrasion of the wires and the crushing, or flattening, of the strand at the "pull," or bearing, of the strand in the eye.

Stays should have some rust-resisting coating. Tinning and galvanizing wire is the most common and inexpensive method of preventing rust. Although steel wire loses but 2 per cent of its strength in the process of tinning, tinned wire corrodes.

Galvanized wire resists rust much longer than tinned wire, but galvanizing a steel wire reduces its strength about 8 per cent, and steel wires especially of small sizes do not possess as uniform strength after galvanizing, as can be demonstrated by testing the wires composing galvanized stay strand.

A better stay preservative than either tinning or galvanizing is needed. This suggests a heavy electro-copper or nickel-plate, an elastic weather-proof paint or varnish to be applied to the completed stay, none of which would impair the strength of the stay.

Perhaps this feature has not received proper consideration in selecting wire for stays. As is well-known, Wohler found that "Rupture of metal may be caused by repeated vibrations, none of which attain the absolute breaking limit."

Steel wire ropes used to guy battleship smoke-stacks have broken when under no unusual strain, because the wires had become crystallized and brittle from the constant vibrations to which they had been subjected. Airplane stays, like bicycle spokes, must withstand repeated strains and vibration.

The stresses put upon airplane stays when the machine is brought abruptly to a horizontal position after a long swift earthward glide, are tremendous. Such strains, accompanied by the inevitable stretching of the wires and the usual tightening of the turnbuckles, destroys the elasticity of the wire, while the incessant vibration crystallizes the steel, so that eventually the stays are unable to sustain the load which they carried safely when new.

It would help airplane constructors to decide upon the best qualities and sizes of stay wire and stay strand, if there were available actual strength, elongation, and torsion tests of stay wires and of the wires for stay strands when new, and, for comparison, authentic tests of the wires from stays after they have been in use a definite time. Such tests would probably demonstrate the wisdom of adopting—1, a strong, tough, uniform quality of steel; 2, larger stay wires and strands than commonly used; and, 3, the practice of renewing all wire stays after a certain length of service.

But without the benefit of such tests, practical experience appears to favor a solid wire stay of the best grade of crucible steel rope wire, or bicycle spoke wire, with a slight annealing to toughen the outside surface of the wire. Although not possessing as great strength as the higher carbon plow steel wire, it would withstand bending, sudden strains, and vibration much better.

As to stay strand, the nineteen wires composing the strand should be of the best quality crucible steel rope wire, the strand to be made in two operations; that is, the center wire should be covered by six wires with a short twist. This seven-wire strand should then be covered, by a separate operation, with twelve wires having a longer twist, the object being to have all wires (except the center wire) of the same length, thus distributing the stresses evenly among the wires.

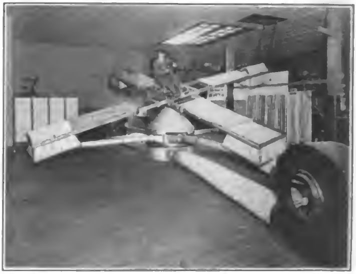
This is not the case when the nineteen wires are twisted into strand in the easiest and cheapest way—that is, in one operation, with the same number of twists in a given length of strand, for the inside six wires wrapped around the center wire are necessarily shorter than the twelve outer wires. Further, the straight center wire should stand greater elongation without breaking than the wires twisted spirally about it.

In conclusion, every manufacturer of airplanes should have rigid specifications and certified tests for all stay wire and wires in stay strands and control-cords, covering strength, elongation, and torsion tests. All wires entering into stay strand and control cord should be reasonably uniform, for it is suicidal to use stay strand or cord containing some high strength steel wires low in elongation, while other wires in the strand or cord are of less strength and greater elongation. Uniformity is best secured by testing the ends of every length of wire on a stranding machine when beginning to twist each spool of strand or cord.

The Terra Tutor

In the photograph reproduced herewith is shown an interesting mechanism devised by A. C. Beech, of the Moler Aviation Instructors.

The pupil is seated on a platform which can be tilted laterally or made to pitch fore and aft, or to turn horizontally about a vertical axis. The platform is equipped with a standard Dep control, and carries four arms as seen in the photograph. A 3-foot blower supplies air to a central chamber under the platform from which air is carried along through pipes to the ends of the four arms. At the ends of these arms are placed air trap gates and rudders.



Just as in the Dep control, the wheel can shut or open the air gates on the side arms and produce or prevent lateral motion. The forward or backward motion of the wheel post produces or prevents pitching in the same manner. The foot bar is connected to a drum which operates the four planes or rudders, one at the end of each arm, and produces or prevents turning.

Airplane Fittings

By J. V. Costello

The term "fittings" as used in this article will apply to any of the metal pieces designed for the purpose of securing together parts of airplanes, such as struts, beams, wires, etc.

The fittings used on some of the early type of foreign built war machines, recently exhibited in this country, were made in large part of aluminum castings. This material, while having the advantage of lightness, is not being used by American manufacturers who are producing machines in quantities.

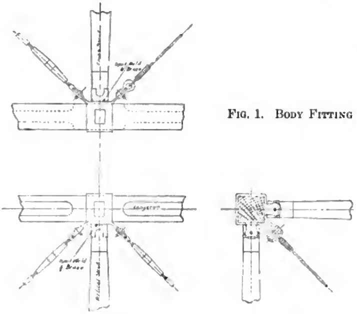


FIG. 1. BODY FITTING

The greater percentage of airplane fittings is easily designed for stampings, and in some instances where great strength is required simple forgings are used, as designs of this character are desirable for rapid production, and being more reliable than castings, the reason for their adoption is obvious.

The grade of material used in stamped fittings varies among different manufacturers. Excellent results are obtained from sheet steel of .20 to .30 per cent carbon content, heat treated, the physical properties of which are 60,000 lb. per sq. in. ultimate strength, yield point 40,000 lb. per sq. in., and 15 per cent elongation in 2 in. A steel averaging between .10 and .15 per cent carbon is used to some extent by manufacturers. Steel of this grade can be used as received from the mill, being softer, can be bent without fracture, and is not given a subsequent heat treatment. However, the tensile strength is lower, averaging 35,000 to 40,000 lb. per sq. in., which requires that the design be made correspondingly heavier than the higher carbon steel.

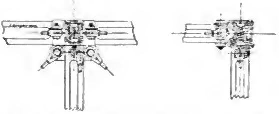


FIG. 3. BODY FITTING

Fittings should be designed to have minimum of material for the required strength. The tensile or compressive strength, however, is not all to be considered when deciding the dimensions of the piece. If it is to be secured to a wood member, the bearing value of the wood must also be considered. If a fitting is designed to take a wire pull, the strength of the ear to which the wire is attached should exceed that of the wire or turnbuckle, as in the event of breakage replacement of a wire is more simple than replacement of a fitting. Sharp

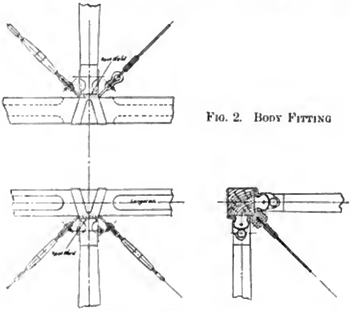


FIG. 2. BODY FITTING

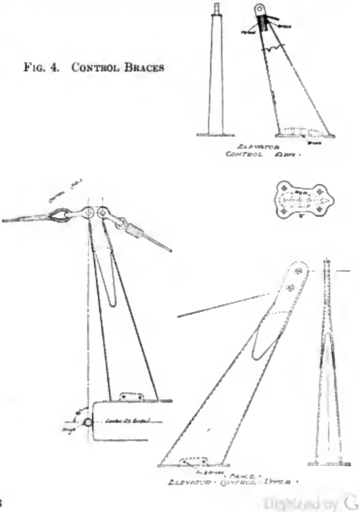


FIG. 4. CONTROL BRACES

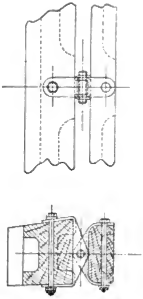


Fig. 5. Aileron Hinge

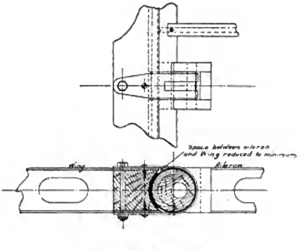


Fig. 7. Aileron Hinge

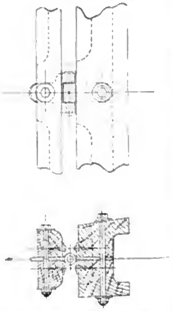


Fig. 6. Aileron Hinge

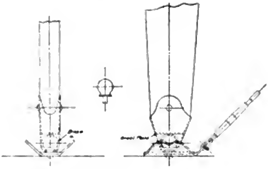


Fig. 8. Ball and Socket Fitting

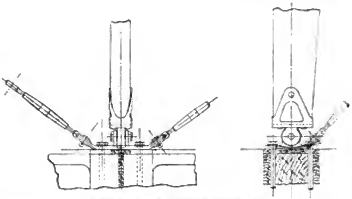


Fig. 9. Inter-Strut Fitting

corners should be avoided in bending fittings, and the designer should indicate a radius in corners equal to at least the thickness of the metal itself.

In Fig. 1, the fitting is made up of three pieces, the two sockets for the struts being spot welded and brazed to the main fitting. Fig. 2 shows a fitting in which the strut sockets and main fitting are made from a single piece with the wire pulls welded to the main fitting. The fitting in Fig. 3 is not as simple in design as those illustrated in Figs. 1 and 2, and an attempt has been made to allow for varying thickness of the longeron. This, to some extent, is also a feature of the others.

The control braces shown in Fig. 4 are made of 1/32 in. cold rolled steel. The flat pattern of the base is shown at *A*. The ears are bent up as indicated, and are slipped into and brazed to the brace. There is a variety of designs of the upper end of the brace, some of which are shown in the diagram.

In designing these braces the point of attachment of the control wire is on a line passing through the center of the hinge, normal to the center line of the aerofoil, as shown in the illustration. This layout gives the least amount of slack in operating the controls.

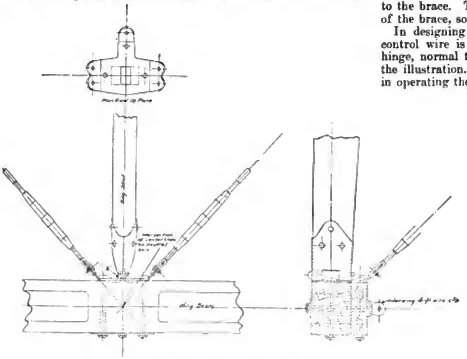


Fig. 10. Inter-Strut Fitting

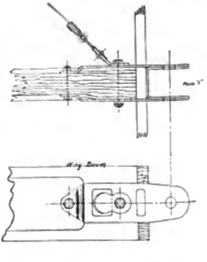


Fig. 11. Wing Hinge

Figs. 5, 6 and 7 indicate several designs of aileron hinges. The fitting shown in Fig. 5 is made up of stampings, and while not as simple as the forgings shown in Fig. 6, it appears more secure in that more advantage is taken of the bearing value of the bolts in the wood.

The hinge shown in Fig. 6 is assembled into a slot in the wing beam and the bolt hole is then drilled. It frequently happens that in lining up the several hinges along a slightly crooked beam the hinge tongue is not inserted to its proper depth. The distance from the center of the bolt to the end of the tongue is made to allow for this variation.

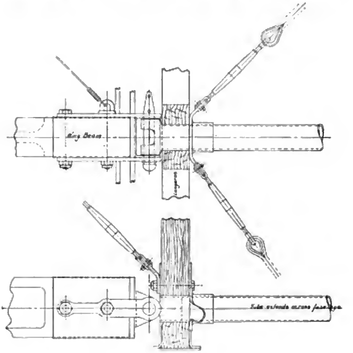


Fig. 12. Wing Hinge

Examples of some interplane strut fittings are shown in Figs. 8, 9 and 10. The fitting shown in Fig. 8 is of ball and socket type and designed to take care of any ordinary dihedral or wing stagger. The plate is designed for the usual wire pulls; the ball is made of cold rolled steel; the stem which projects through the plate is riveted over. The ball socket which is brazed into the strut socket is made from deep drawing steel.

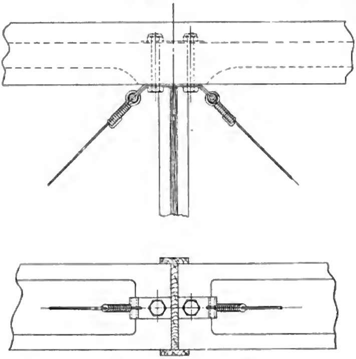


Fig. 14. Wing Drag Braces

The wing plate of Fig. 9 is forged. The ears to which the strut is secured are machined at the proper angle to suit the dihedral angle of the wings. This design permits of several different degrees of wing stagger.

The fitting illustrated in Fig. 10 is designed to overcome the comparatively great wind resistance offered by the two types previously shown. It allows for any wing dihedral and the stagger is allowed for in part X. A point to be noted in connection with this design is the use to which the bolt heads have been put in preventing the wire pulls from being bent out of their position.

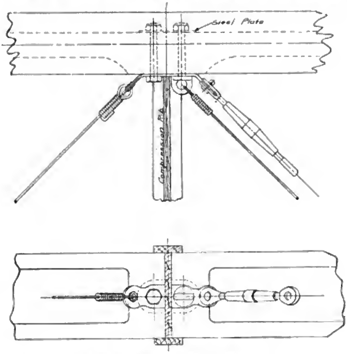


Fig. 13. Wing Drag Braces

Fittings designed to secure the wings to the body are usually made up as a hinge. This design allows flexibility and is quickly assembled. This is one of the most important fittings on the machine. Plate X in Fig. 11 has considerable bearing surface against the end of the beam, and takes the compression shocks due to landing. The hinge is secured to the beam by two bolts and the method of shouldering the end of the fitting in the routing of the beam is worthy of note.

The male portion of the hinge shown in Fig. 12 is welded and brazed into a steel tube which extends across the body, and makes an excellent construction.

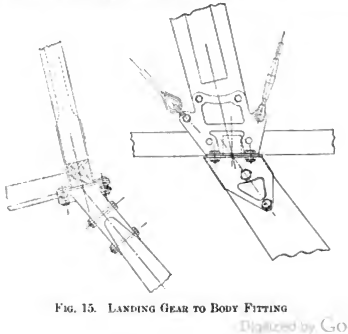


Fig. 15. Landing Gear to Body Fitting

The usual wing drag bracing is shown in Figs. 13 and 14. The plate fitting of Fig. 13 is a simple stamping, having a bushing spun into the end which takes the wire terminal, giving more bearing to the wire loop. This, however, allows distortion of the wire loop, which has been overcome in the design shown in Fig. 14. This is made from a single piece of sheet steel, doubled. The point at which the fold is made is looped out, and fills the eye of the wire terminal.

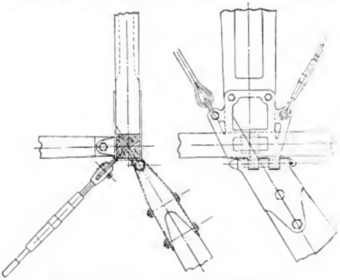


Fig. 16. Landing Gear to Body Fitting

The strut socket fitting shown in Fig. 15 is made up from 1/32 in. sheet steel welded to the flange plate, which is solid, giving full bearing area to the end of the strut. The socket is bolted to the simple body fitting with four nickel steel bolts.

The strut socket illustrated by Fig. 16 is of the pin variety, is quickly assembled, and gives good streamlining. It will be noted in the drawing that the center lines of the various numbers meet at a common point, which is a desirable feature.

Considerable difference of opinion exists in regard to the merits of welded fittings and those that are brazed. Without question, some fittings, owing to their shape, lend themselves better to the practice of welding than brazing, and vice versa. Take for instance, tubing: Where several pieces of tubing are put together a neater job and an easier one is obtained if the parts are torch welded.

In the case of flat surfaces of several square inches area, brazing is advantageous in that the brazing metal can be flowed over the whole area of the joint, whereas the torch can weld only around the edge. Of course, the spot welder may be utilized here, provided the thickness of the sheet and general dimensions of the piece permits this operation.

A serious objection to the practice of brazing is that the temperature to which the metal is raised changes the structure of the steel used for fittings.

In attempts to heat-treat fittings which have been brazed, even with brazing metals of comparatively high melting points, sufficient success has not been met with to warrant the adoption of this practice. The brazing metal of so called high melting point melts at temperatures between 1,600 and 1,700 deg., and the heat required in heat treating, ranging as it does from 1,550 to 1,650 deg., depending on the steel, causes the brazing metal to flow more or less, leaving small openings in the seams, which have to be refilled.

In connection with brazing, the use of borax as a flux results in a fitting with a surface of melted borax, which is removed with difficulty. Substitution of boracic acid as a flux overcomes this difficulty, as boracic acid is easily removed by washing the parts in water.

Welded parts always require a subsequent heat treatment if the full strength of the material is to be obtained.

Fittings on which the welds are apparently sound will sometimes reveal, when broken, that the welding metal has not properly fused. It is this unreliability which has influenced some engineers against the torch welded fitting. Imperfect welds are traceable to unskilled or careless workmen.

The practices of brazing and that of welding give excellent results in their proper places, but the homeogeneity of welding, permitting as it does proper heat treating, appears to offer the better results.

The Lawson Training Airplane

The primary training airplane of the Lawson Aircraft Corporation of Green Bay, Wis., is a tractor two-seater biplane and is built to the United States Army specifications, No. 1,000.

The principal characteristics claimed for this machine are the following:

Span.—Upper	44 ft.
Lower	32 ft.
Chord.—Upper	7 ft.
Lower	6 ft.
Gap	6 ft.
Overall length	25 ft.
Wing curve	U. S. A. 5

Power plant one 4-cyl., 100 hp. engine (Hall-Scott model A-7a).

Speed.—High	67 m.p.h.
Low	37 m.p.h.
Climb	2600 ft. in 10 min.
Weight, light	1250 lb.
Useful load	550 lb.

International Aircraft Standards

(Continued from last issue)

3N6—Specifications for Soft Brass Sheet

General.—1. The general specification 1G1 shall form, according to their applicability, a part of these specifications.

Material.—2. (*a*) The brass shall have the following chemical composition:

	Per cent.
Copper	79 to 85
Lead, maximum	0.15
Iron, maximum	0.08
Zinc	Remainder.

(*b*) Drillings or clippings for analysis shall be taken from both ends of the coil sampled and shall be free from all surface oxide or dirt.

Manufacture.—3 (*a*) The brass used shall be crucible melted from lake or electrolytic copper according to I. A. S. B. specification 2N2, and spelter B or C grade according to I. A. S. B. specification 2N3.

(*b*) No scrap shall be used except such as may accumulate in the manufacturer's plants from material of the same composition and of their own make.

(*c*) All sheet must be fully annealed after rolling.

Workmanship and Finish.—4. The surface of the brass shall be clean and smooth, and it shall be free from injurious defects such as blisters, slivers, or dirt embedded in the surface.

Physical Properties and Tests.—5. (*a*) Specimens taken from any lot shall have a minimum tensile strength of 40,000 lb. per square inch (28.12 kg. per mm.).

(*b*) A specimen similar to test sample must withstand being bent double in any direction and hammered flat, so that a gage set at twice the thickness of the metal will pass freely over the bend.

Selection of Test Specimen.—6. When shipments are made in coils a specimen from every tenth coil shall be taken for physical tests. When shipments are made in short lengths a specimen will be taken from each case.

Dimensions and Tolerances.—7. The tolerances allowed shall be as given in the following table:

TOLERANCES.

English Units.

American Wire Gage (B. & S.).	Thickness, inches.	Tolerance, inches. Less than 5 inches wide.	5 to 8 inches wide.	8 to 11 inches wide.	11 to 14 inches wide.
No. 8 to 14	0.1285 to 0.0641	±0.0029	±0.0033	±0.0036	±0.0040
No. 15 to 18	.0571 to .0403	± .0025	± .0029	± .0033	± 0037
No. 19 to 24	.0359 to .0201	± .0020	± .0024	± .0028	± .0032
No. 25 to 28	.0179 to .0126	± .0016	± .0020	± .0024	± .0028
No. 29 to 32	.0113 to .0080	± .0013	± 0017	± .0020	± .0024

Metric Units.

American Wire Gage (B. & S.).	Thickness, millimeters.	Tolerance, millimeters. Less than 127 mm. wide.	127 to 203 mm. wide.	203 to 279 mm. wide.	279 to 356 mm. wide.
No. 8 to 14	3.264 to 1.628	±0.074	±0.084	±0.091	±0.102
No. 15 to 18	1.450 to 1.024	± .064	± .074	± .084	± .094
No. 19 to 24	.912 to .511	± .051	± .061	± .071	± .081
No. 25 to 28	.455 to .321	± .041	± .051	± .061	± .071
No. 29 to 32	.286 to .202	± .033	± .043	± .051	± .061

Delivery, Packing, and Shipping.—8. (*a*) When orders call for 12-ft. (3.66-m.) lengths, the following tolerances as to lengths will be allowed, but in no case shall the aggregate amount of these short lengths exceed 40 per cent:

40 per cent may be 10 feet (3.05 meters) or over.
30 per cent may be 8 feet (2.44 meters) to 10 feet (3.05 meters).
20 per cent may be 6 feet (1.83 meters) to 8 feet (2.44 meters).
10 per cent may be 4 feet (1.22 meters) to 6 feet (1.83 meters).

When orders call for 10-ft. (3.05-m.) lengths, the following tolerances as to lengths will be allowed, but in no case shall the aggregate amount of these short lengths exceed 40 per cent:

40 per cent may be 8 feet (2.44 meters) or over.
30 per cent may be 6 feet (1.83 meters) to 8 feet (2.44 meters).
20 per cent may be 4 feet (1.22 meters) to 6 feet (1.83 meters).
10 per cent may be 2 feet (0.61 meter) to 4 feet (1.22 meters).

When orders call for 8-ft. (2.44-m.) lengths, the following tolerances as to lengths will be allowed, but in no case shall the aggregate amount of these short lengths exceed 30 per cent:

30 per cent may be 6 feet (1.83 meters) or over.
20 per cent may be 4 feet (1.22 meters) to 6 feet (1.83 meters).
10 per cent may be 2 feet (0.61 meter) to 4 feet (1.22 meters).

When orders call for 6-ft. (1.83-m.) lengths, the following tolerances as to lengths will be allowed, but in no case shall the aggregate amount of these short lengths exceed 20 per cent:

20 per cent may be 4 feet (1.22 meters) or over.
10 per cent may be 2 feet (0.61 meter) to 4 feet (1.22 meters).

(*b*) Coils shall not contain more than four lengths, and lengths shall be at least 10 ft. (3.05 m.) long.

3N8—Specifications for Sheet Copper

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. (*a*) The copper used shall be lake or electrolytic, conforming with the I. A. S. B. specifications 2N2, and shall be hot rolled or hot rolled and finished by cold rolling and annealing or by final cold rolling as required.

(*b*) Chemical analysis shall not be required; but samples may be taken for analysis to check the quality of the material used, in which case the sheet, after being thoroughly cleaned from all oxide and dirt, must show a purity of 99.85 per cent copper plus silver.

Workmanship and Finish.—3. The material shall be clean, smooth, or uniform color, and shall be free from all injurious defects.

Physical Properties and Tests.—4. (*a*) The sheets shall have the following physical properties:

TENSILE TESTS

Grade.	Minimum tensile strength.	Minimum elongation in 2 inches (50.8 mm.).
Soft	30,000 pounds per square inch (21.09 kg./mm.^2)	25 per cent.
Hard	35,000 pounds per square inch (24.61 kg./mm.^2)	18 per cent.

(*b*) Sheets less than 0.072 in. (1.83 mm.) thick are not subject to physical test.

(*c*) The tensile strength of hard-rolled thin sheets will be considerably more and the elongation considerably less than that indicated in the above table.

Bend Test.—(*d*) The soft sheets must withstand bending flat on themselves in any direction without cracking.

Selection of Test Specimens.—5. One test shall be taken from each lot of 500 lb. (226.8 kg.) or less.

Dimensions and Tolerances.—6. (*a*) The weight or thickness shall not vary more than 5 per cent from that specified. Thickness shall be specified in decimals of an inch or millimeter and shall correspond to the ordinary gage numbers.

(*b*) For wide sheets or plates above 48 in. (1,219 mm.), to and including 60 in. (1,524 mm.), a tolerance of 5 per cent over or 7 per cent under gage or weight will be allowed.

(*c*) For extra wide sheets or plates above 60 in. (1,524 mm.) in width the tolerance may be 5 per cent over or 8 per cent under gage or weight.

(*d*) For the purpose of calculating weights, etc., the specific gravity of copper shall be taken as 8.89 at 20 deg. C., or 0.3212 lb. per cu. in. (8.89 g. per cm.^3).

Delivery, Packing, and Shipping.—7. (*a*) When orders call for 12-ft. (3.66-m.) lengths, the following tolerances as to lengths will be allowed, but in no case shall the aggregate amount of these short lengths exceed 40 per cent:

40 per cent may be 10 feet (3.05 meters) or over.
30 per cent may be 8 feet (2.44 meters) to 10 feet (3.05 meters).
20 per cent may be 6 feet (1.83 meters) to 8 feet (2.44 meters).
10 per cent may be 4 feet (1.22 meters) to 6 feet (1.83 meters).

When orders call for 10-ft. (3.05-m.) lengths, the following tolerances as to lengths will be allowed, but in no case shall the aggregate amount of these short lengths exceed 40 per cent:

40 per cent may be 8 feet (2.44 meters) or over.
30 per cent may be 6 feet (1.83 meters) to 8 feet (2.44 meters).
20 per cent may be 4 feet (1.22 meters) to 6 feet (1.83 meters).
10 per cent may be 2 feet (0.61 meter) to 4 feet (1.22 meters).

When orders call for 8-ft. (2.44-m.) lengths, the following tolerances as to lengths will be allowed, but in no case shall the aggregate amount of these short lengths exceed 30 per cent:

30 per cent may be 6 feet (1.83 meters) or over.
20 per cent may be 4 feet (1.22 meters) to 6 feet (1.83 meters).
10 per cent may be 2 feet (0.61 meter) to 4 feet (1.22 meters).

When orders call for 6-ft. (1.83-m. lengths, the following tolerances as to lengths will be allowed, but in no case shall the aggregate amount of these short lengths exceed 20 per cent:

20 per cent may be 4 feet (1.22 meters) or over.
10 per cent may be 2 feet (0.61 meter) to 4 feet (1.22 meters).

(*b*) Below 1 in. (25.4 mm.) wide sheet copper may be furnished in rolls or coils, in which case it will be cold rolled or cold rolled and annealed.

3N9—Specification for Phosphor-Bronze Strip

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Use.—2. This strip to be used for springs.

Material.—3. (*a*) The bronze shall conform to the following chemical composition:

	Per cent
Copper	91 to 93
Zinc, maximum	0.20
Iron, maximum	0.10
Phosphorus, maximum	0.15
Tin	Remainder.

(*b*) Drillings or clippings for analysis shall be taken from both ends of the coil sampled and shall be free from all surface oxide or dirt.

Manufacture.—4. (*a*) The bronze shall be crucible melted from lake or electrolytic copper, according to I. A. S. B. specification 2N2 and best Straits' or equivalent tin and deoxidized with phosphorus.

(*b*) No scrap shall be used except such as may accumulate in the manufacturer's plants from material of the same composition and of their own make.

(*c*) All strip shall be rolled to spring temper unless otherwise ordered.

Workmanship and Finish.—5. The surface of the strip shall be clean and smooth, and it shall be free from injurious defects such as blisters, slivers, or dirt embedded in the surface.

Physical Properties and Tests.—6. Phosphor-bronze spring strip shall have the following physical properties:

Tensile Strength.	Yield Point.	Elongation in 2 inches (50.8 mm.)
Minimum, 85,000 pounds per square inch (59.76 kg./mm².).	65,000 pounds per square inch (45.70 kg./mm².).	5 per cent.
Maximum, 115,000 pounds per square inch (80.85 kg./mm².).	95,000 pounds per square inch (66.79 kg./mm².).	20 per cent.

Selection of Test Specimens.—7. When shipments are made in coils, a specimen from every tenth coil shall be taken for physical tests. When shipments are made in short lengths, a specimen will be taken from each case.

Dimensions and Tolerances.—8. The tolerances allowed shall be as given in the following table:

TOLERANCES.
English Units.

American Wire Gage (B. & S.).	Thickness, inches.	Tolerance, inches.			
		Less than 5 inches wide.	5 to 8 inches wide.	8 to 11 inches wide.	11 to 14 inches wide.
No. 8 to 14	0.1285 to 0.0641	±0.0029	±0.0033	±0.0036	±0.0040
No. 15 to 18	.0571 to .0403	± .0025	± .0029	± .0033	± .0037
No. 19 to 24	.0359 to .0201	± .0020	± .0024	± .0028	± .0032
No. 25 to 28	.0179 to .0126	± .0016	± .0020	± .0024	± .0028
No. 29 to 32	.0113 to .0080	± .0013	± .0017	± .0020	± .0024

Metric Units.

American Wire Gage (B. & S.).	Thickness, millimeters.	Tolerance, millimeters.			
		Less than 127 mm. wide.	127 to 203 mm. wide.	203 to 279 mm. wide.	279 to 356 mm. wide.
No. 8 to 14	3.264 to 1.628	±0.074	±0.084	±0.091	±0.102
No. 15 to 18	1.450 to 1.024	± .064	± .074	± .084	± .094
No. 19 to 24	.912 to .511	± .051	± .061	± .071	± .081
No. 25 to 28	.455 to .321	± .041	± .051	± .061	± .071
No. 29 to 32	.286 to .202	± .033	± .043	± .051	± .061

Delivery, Packing, and Shipping.—9. (*a*) When orders call for 12-ft. (3.66-m.) lengths, the following tolerances as to lengths will be allowed, but in no case shall the aggregate amount of these short lengths exceed 40 per cent:

40 per cent may be 10 feet (3.05 meters) or over.
30 per cent may be 8 feet (2.44 meters) to 10 feet (3.05 meters).
20 per cent may be 6 feet (1.83 meters) to 8 feet (2.44 meters).
10 per cent may be 4 feet (1.22 meters) to 6 feet (1.83 meters).

When orders call for 10-ft. (3.05-m.) lengths, the following tolerances as to lengths will be allowed, but in no case shall the aggregate amount of these short lengths exceed 40 per cent:

40 per cent may be 8 feet (2.44 meters) or over.
30 per cent may be 6 feet (1.83 meters) to 8 feet (2.44 meters).
20 per cent may be 4 feet (1.22 meters) to 6 feet (1.83 meters).
10 per cent may be 2 feet (0.61 meters) to 4 feet (1.22 meters).

When orders call for 8-ft. (2.44-m.) lengths, the following tolerances as to lengths will be allowed, but in no case shall the aggregate amount of these short lengths exceed 30 per cent:

30 per cent may be 6 feet (1.83 meters) or over.
20 per cent may be 4 feet (1.22 meters) to 6 feet (1.83 meters).
10 per cent may be 2 feet (0.61 meter) to 4 feet (1.22 meters).

When orders call for 6-ft. (1.83-m.) lengths, the following tolerances as to lengths will be allowed, but in no case shall the aggregate amount of these short lengths exceed 20 per cent:

20 per cent may be 4 feet (1.22 meters) or over.
10 per cent may be 2 feet (0.61 meter) to 4 feet (1.22 meters).

(*b*) Coils shall not contain more than four lengths, and lengths shall be at least 10 ft. (3.05 m.) long.

3S13—Specifications for 19 Nonflexible Steel-Wire Cable

General.—1. (*a*) This specification covers the finish, material, and construction of high strength steel-wire cable composed of steel wires twisted concentrically about a steel wire as center.

(*b*) The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material—2. The wire shall be manufactured of either I. A. S. B. standard steel No. 1065, No. 1070, or No. 1080, the compositions of which are listed below.

Manufacture—3. (*a*) The steel wires composing the cable shall be laid around the center wire in one or two layers as required by the number of wires in the cable with a left-hand (counter-clockwise) pitch and with a length of lay not to exceed 11 times the diameter of the cable or not less than 9 times the diameter of the cable.

(*b*) The steel from which the wires composing the cable are drawn shall be manufactured by the acid open-hearth process.

(*c*) Wires composing the cable shall be uniformly coated with pure tin to solder readily.

(*d*) Joints in wires composing the cable shall be brazed in a gas fire. Tucked in, welded, or twisted joints will not be permitted. No two brazed joints in individual wires shall be closer to one another in the completed cable than 150 feet (45.72 m.). All brazed joints in wires shall be tinned. Exposed brass at joints shall not constitute cause for rejection.

Workmanship and Finish—4. Each length of cable is to be evenly laid and free from kinks, loose wires, or other irregularites. The cable shall remain in this condition when unwound from the reel or bent around a standard thimble, proper precautions being taken to secure the ends

Physical Properties and Tests: *Tensile Test.*—5. (*a*) A tensile test shall be made upon each reel of cable purchased of a size.

(*b*) Samples of cable for testing tensile strength shall be not less than 24 in. (610 mm.) in length. In making tensile tests the distance between jaws of testing machine, with sample in place and before set, shall be not less than 10 in. (254 mm.).

(*c*) Samples for tensile test may be clamped in the jaws of the testing machine in the usual manner to facilitate testing, but in case of failure or dispute on individual tests, and at the request of the manufacturer, check tests shall be made by socketing the samples with pure zinc.

(*d*) Cable for use in the construction of aircraft shall meet the required breaking strength specified in the table.

Bend Test.—(*e*) One bend test is to be made on a sample cut from each reel of cable of a given size. Each sample must be bent once around its own diameter and straightened again at least 20 times in succession in the same direction of bending without any of the wires breaking.

Torsion Test.—(*f*) A torsion test is to be made on one wire from each sample of cable taken for tensile test. The wire is to be gripped by two vises 8 in. (203 mm.) apart. One vise shall be turned uniformly at as high a rate of speed as possible without perceptibly heating the wire; one vise shall have free axial movement in either direction.

(*g*) The number of complete turns which the wire shall stand is determined by the formula:

$$\text{Number of turns} = \frac{2.2}{\text{diameter in inches}} = \frac{55.9}{\text{diameter in millimeters.}}$$

(*h*) Failure of one piece of wire to show full number of turns specified in the above torsion test shall not be considered cause for rejection, but in such case two additional tests shall be made on two more wires from the same sample of cable, and if both samples meet the requirements of the specification the cable shall be accepted in this respect.

Dimensions and Tolerances.—6. There shall be no permissible variation in gage below size. Cable having a diameter of 0.031 ($\frac{1}{32}$) to 0.156 ($\frac{5}{32}$) inch (0.79 to 3.97 mm.), inclusive, shall have a permissible variation of 10 per cent above size, and cable having a diameter of 0.187 ($\frac{3}{16}$) to 0.375 ($\frac{3}{8}$) inch 4.76 to 9.53 mm.), inclusive, shall have a permissible variation of 7 per cent above size.

DELIVERY, PACKING, AND SHIPPING.—7. (*a*) All cable shall be shipped on reels in lengths and sizes as specified on orders.

(*b*) The dimensions of reels for different lengths and sizes of cable shall conform to the table attached to this specification.

(*c*) A tinned or galvanized steel seal wire of approved design shall pass around no less than three convolutions of the cable on the reel and shall pass through a linen tag showing the name of the manufacturer, the size and length of cable on the reel, the order number or other distinguishing marks, and a record of the test for tensile strength. A lead seal impressed with the official stamp of the representative of the Government making the inspection shall secure the ends of this seal wire and furnish evidence of inspection and acceptance.

(*d*) The outer layers of cable on a reel ready for shipment shall be protected from mechanical injury in handling and transportation by an efficient covering of burlap.

CHEMICAL COMPOSITIONS OF STANDARD CARBON STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.
1065	0.60-0.70	0.50-0.70	0.040	0.045
1070	.65- .75	.50- .70	.040	.045
1080	.75- .90	.25- .50	.040	.045

TABLE OF WEIGHTS, SIZES, AND STRENGTH OF CABLE.

English Units.			Metric Units.		
Diameter, inches.	Breaking strength, pounds.	Approximate weight, pounds per 100 feet.	Diameter, millimeters	Breaking strength, kilograms.	Approximate weight, kilograms per 100 meters.
0.312 (5/16)	12,500	20.65	7.938	5,670	30.73
.250 (1/4)	8,000	13.50	6.350	3,629	20.09
.218 (7/32)	6,100	10.00	5.556	2,767	14.88
.187 (3/16)	4,600	7.70	4.763	2,087	11.46
.156 (5/32)	3,200	5.50	3.969	1,451	8.18
.125 (1/8)	2,100	3.50	3.175	953	5.21
.109 (7/64)	1,600	2.60	2.778	726	3.87
.094 (3/32)	1,100	1.75	2.381	498.9	2.60
.078 (5/64)	780	1.21	1.984	353.8	1.80
.062 (1/16)	500	78	1.588	226.8	1.16
a.031 (1/32)	185	.30	a.794	83.9	.45

a7 wire.

REELS FOR CABLE.

ENGLISH UNITS.

Diameter of cable.	1,000 feet.				3,000 feet.				5,000 feet.				10,000 feet.			
	Diameter of head.	Traverse or distance between heads.	Diameter of bundle.	Diameter of arbor hole.	Diameter of head.	Traverse or distance between heads.	Diameter of bundle.	Diameter of arbor hole.	Diameter of head.	Traverse or distance between heads.	Diameter of bundle.	Diameter of arbor hole.	Diameter of head.	Traverse or distance between heads.	Diameter of bundle.	Diameter of arbor hole.
In.	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*
1/32	12	4	8	1⅛	12	4	8	1⅛	12	4	8	1⅛	16	4	10	1⅛
1/16	12	4	8	1⅛	12	4	8	1⅛	16	4	10	1⅛	16	7	12	1⅛
5/64	12	4	8	1⅛	16	4	10	1⅛	16	7	12	1⅛	16	10	8	1⅛
3/32	12	4	8	1⅛	16	4	10	1⅛	16	7	12	1⅛	16	10	8	1⅛
7/64	16	4	10	1⅛	16	7	12	1⅛	16	10	8	1⅛	18	10	8	1⅛
1/8	16	4	10	1⅛	16	7	12	1⅛	16	10	8	1⅛	24	10	10	1⅛
9/64	16	7	12	1⅛	16	10	8	1⅛	24	10	10	1⅛	24	16	10	2⅛
5/32	16	7	12	1⅛	16	10	8	1⅛	24	10	10	1⅛	24	16	10	2⅛
3/16	18	7	12	2⅛	18	10	8	2⅛	24	10	10	2⅛	24	16	10	2⅛
7/32	18	7	12	2⅛	18	10	8	2⅛	24	10	10	2⅛	32	20	16	3⅛
1/4	18	10	10	2⅛	24	10	10	2⅛	32	18	16	2⅛	36	22	18	3⅛
5/16	18	10	10	2⅛	24	10	10	2⅛	32	18	16	2⅛	36	22	18	3⅛
11/32	18	10	8	2⅛	32	16	16	2⅛	32	20	16	3⅛	50	16	26	3⅛
3/8	18	10	8	2⅛	32	16	16	2⅛	32	20	16	3⅛	50	16	26	3⅛

METRIC UNITS.

	305 meters.				914 meters.				1,524 meters.				3,048 meters.			
mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
0.794	305	102	203	28.58	305	102	203	28.58	305	102	203	28.58	406	102	254	28.58
1.588	305	102	203	28.58	305	102	203	28.58	406	102	254	28.58	406	178	305	28.58
1.984	305	102	203	28.58	406	102	254	28.58	406	178	305	28.58	406	254	203	28.58
2.381	305	102	203	28.58	406	102	254	28.58	406	178	305	28.58	406	254	203	28.58
2.778	406	102	254	28.58	406	178	305	28.58	406	254	203	28.58	457	254	203	28.58
3.175	406	102	254	28.58	406	178	305	28.58	406	254	203	28.58	610	254	254	28.58
3.572	406	178	305	28.58	406	254	203	28.58	610	254	254	28.58	610	406	254	53.98
3.969	406	178	305	28.58	406	254	203	28.58	610	254	254	28.58	610	406	254	53.98
4.763	457	178	305	53.98	457	254	203	53.98	610	254	254	53.98	610	406	254	53.98
5.556	457	178	305	53.98	457	254	203	53.98	610	254	254	53.98	813	508	406	79.38
6.350	457	254	254	53.98	610	254	254	53.98	813	457	406	53.98	914	560	457	79.38
7.938	457	254	254	53.98	610	254	254	53.98	813	457	406	53.98	914	560	457	79.38
8.731	457	254	203	53.98	813	406	406	53.98	813	508	406	79.38	1,270	406	660	79.38
9.525	457	254	203	53.98	813	406	406	53.98	813	508	406	79.38	1,270	406	660	79.38

In making racks for the above reels allow a 4-in. or 102-mm., greater width than the traverse specified below.

2N1—*Specifications for Ingot Aluminum*

GENERAL—The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL—2. (*a*) Three grades of ingot aluminum are recognized:

		Per cent.
Standard No. 1, aluminum	not less than	99.0
Standard No. 2, aluminum	"	98.0
Special, aluminum	"	99.5

Analysis—(*b*) One sample ingot of each heat shall be taken for analysis, and in any case not less than one sample ingot from each 500 lb. (226.8 kg.) of metal.

(*c*) Samples shall be obtained by drilling completely through the ingot or half through from top to bottom. The weight of the samples obtained by drilling the ingot or ingots should not be less than 120 grams.

MANUFACTURE—3. No scrap shall be used except such as shall accumulate at the manufacturer's plant from material of the same composition and of their own make.

3S14—*Specifications for 7 x 7 Flexible Steel-Wire Cable*

GENERAL.—1. (*a*) This specification covers the finish, material, and construction of high-strength steel-wire cable composed of steel wires twisted concentrically around a steel-wire center, thus forming a strand, and such strands twisted concentrically around a central strand of the same construction, forming a cable.

(*b*) The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The wire shall be manufactured of either I. A. S. B. standard steel, No. 1065, No. 1070, or No. 1080, the compositions of which are listed below.

MANUFACTURE.—3. (*a*) The steel wires composing the individual strands of the cable shall be laid concentrically around the center wire in one layer of six wires with a left-hand (counter-clockwise) pitch or lay. The cable itself shall be constructed by twisting six of these strands composed of seven wires each around a seventh strand of the same construction and material with a right-hand (clockwise) pitch and with a length of lay of six to eight times the diameter of the whole.

(*b*) The steel from which the wires composing the cable are drawn shall be manufactured by the acid open-hearth process.

(*c*) Wires composing the cable shall be uniformly coated with pure tin to solder readily.

(*d*) Joints in wires in cable having a diameter of 0.156 (5/32) inch (3.969 mm.) and larger shall be brazed in a gas fire. In cable having a diameter of 0.125 (⅛) inch (3.175 mm.) or less, wires may be joined either by brazing or twisting, at the manufacturer's convenience. Tucked-in or welded joints are not permitted. No two joints in individual wires shall be closer to one another in the completed cable than 30 ft. (9.14 m.). All brazed joints shall be tinned. Exposed brass at joints shall not constitute cause for rejection.

WORKMANSHIP AND FINISH.—4. Each length of cable is to be evenly laid, and free from kinks, loose wires, or other irregularities. The cable shall remain in this condition when unwound from the reel or bent around a standard thimble, proper precautions being taken to secure the ends.

PHYSICAL PROPERTIES AND TESTS.—*Tensile test.*—5 (*a*) A tensile test shall be made upon each individual reel of cable purchased of a size.

(*b*) Samples of cable for testing for tensile strength shall be no less than 24 in. (610 mm.) in length. In making tests the distance between jaws of testing machine with sample in place and before test shall be not less than 10 in. (254 mm.).

(*c*) Samples for tensile test may be clamped in the jaws of the testing machine in the usual manner to facilitate testing; but in case of failure or dispute on individual tests and at the request of the manufacturer check tests shall be made by socketing the samples with pure zinc.

(*d*) Cable for use in the construction of aircraft shall meet the required breaking strength specified in the table.

Bend Test.—(*e*) One bend test is to be made on a sample cut from each reel of cable of a given size. Each sample must be bent once around its own diameter and straightened again at least 20 times in succession in the same direction of bending without any of the wires breaking.

Torsion Test.—(*f*) A torsion test is to be made on one wire from each sample of cable for tensile test. The wire is to be gripped by two vises 8 in. (203 mm.) apart. One vise shall be turned uniformly at as high a rate of speed as possible without perceptibly heating the wire. One vise shall have free axial movement in either direction.

(*g*) The number of complete turns which the wire shall stand is determined by the formula:

$$\text{Number of turns} = \frac{2.2}{\text{diameter in inches}} = \frac{55.9}{\text{diameter in millimeters.}}$$

(*h*) Failure of one piece of wire to show full number of turns specified in the above torsion test shall not be considered cause for rejection, but in such case two additional tests shall be made on two more wires from the same sample of cable, and if both samples meet the requirements of the specifications the cable shall be accepted in this respect.

Dimensions and Tolerances.—6. There shall be no permissible variation in gage below size. Cable having a diameter of 1/16 to 3/32 in. (1.59 to 2.38 mm.), inclusive, shall have a permissible variation of 12 per cent above size; cable having a diameter of 1/8 to 3/16 in. (3.18 to 4.76 mm.) inclusive, shall have a permissible variation of 10 per cent above size; and cable having a diameter of 7/32 to 3/8 in. (5.56 to 9.53 mm.), inclusive, shall have a permissible variation of 7 per cent above size.

Delivery, Packing, and Shipping.—7. (*a*) All cable shall be shipped on reels in lengths as specified on orders.

(*b*) The dimensions of reels for different lengths and sizes of cable shall conform to the table attached to this specification.

(*c*) A tinned or galvanized steel seal wire of approved design shall pass around no less than three convolutions of the cable on the reel and shall pass through a linen tag showing the name of the manufacturer, the size and length of cable on the reel, the order number or other distinguishing marks, and a record of the test for tensile strength. A lead seal impressed with the official stamp of the representative of the Government making the inspection shall secure the ends of this seal wire and furnish evidence of inspection and acceptance.

(*d*) The outer layer of cable on a reel ready for shipment shall be protected from mechanical injury in handling and transportation by an efficient covering of burlap.

CHEMICAL COMPOSITION OF STANDARD CARBON STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.
1065	0.60–0.70	0.50–0.70	0.040	0.045
1070	.65– .75	.50– .70	.040	.045
1080	.75– .90	.25– .50	.040	.045

TABLE OF WEIGHTS, SIZES, AND STRENGTHS OF CABLE.

English Units.			Metric Units.		
Diameter, inch.	Minimum breaking strength, pounds.	Approximate weight, pounds per 100 feet.	Diameter, millimeters.	Minimum breaking strength, kilograms.	Approximate weight, kilograms per 100 meters.
0.312 (5/16)	9,200	16.70	7.938	4,173	24.85
.250 (1/4)	5,800	10.50	6.350	2,631	15.63
.218 (7/32)	4,600	8.30	5.556	2,087	12.35
.187 (3/16)	3,200	5.80	4.763	1,451	8.63
.156 (5/32)	2,600	4.67	3.969	1,179	6.95
.125 (1/8)	1,350	2.45	3.175	612	3.65
.094 (3/32)	920	1.45	2.381	417	2.14
.078 (5/64)	550	.83	1.984	249	1.26
.062 (1/16)	480	.81	1.588	218	1.21

REELS FOR CABLE.

English Units.

Diameter of strand or cable.	Diameter of head.	Traverse or distance between heads.	Diameter of bundle.	Diameter of arbor hole.	Diameter of head.	Traverse or distance between heads.	Diameter of bundle.	Diameter of arbor hole.	Diameter of head.	Traverse or distance between heads.	Diameter of bundle.	Diameter of arbor hole.	Diameter of head.	Traverse or distance between heads.	Diameter of bundle.	Diameter of arbor hole.
	1,000 feet.				3,000 feet.				5,000 feet.				10,000 feet.			
In.	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*
1/32	12	4	8	1⅛	12	4	8	1⅛	12	4	8	1⅛	16	4	10	1⅛
1/16	12	4	8	1⅛	12	4	8	1⅛	16	4	10	1⅛	16	7	12	1⅛
5/64	12	4	8	1⅛	16	4	10	1⅛	16	7	12	1⅛	16	10	8	1⅛
3/32	12	4	8	1⅛	16	4	10	1⅛	16	7	12	1⅛	16	10	8	1⅛
7/64	16	4	10	1⅛	16	7	12	1⅛	16	10	8	1⅛	18	10	8	1⅛
1/8	16	4	10	1⅛	16	7	12	1⅛	16	10	8	1⅛	24	10	10	1⅛
9/64	16	7	12	1⅛	16	10	8	1⅛	24	10	10	1⅛	24	16	10	2⅛
5/32	16	7	12	1⅛	16	10	8	1⅛	24	10	10	1⅛	24	16	10	2⅛
3/16	18	7	12	2⅛	18	10	8	2⅛	24	10	10	2⅛	24	16	10	2⅛
7/32	18	7	12	2⅛	18	10	8	2⅛	24	10	10	2⅛	32	20	16	3⅛
1/4	18	10	10	2⅛	24	10	10	2⅛	32	18	16	2⅛	36	22	18	3⅛
5/16	18	10	10	2⅛	24	10	10	2⅛	32	18	16	2⅛	36	22	18	3⅛
11/32	18	10	8	2⅛	32	16	16	2⅛	32	20	16	3⅛	50	16	26	3⅛
3/8	18	10	8	2⅛	32	16	16	2⅛	32	20	16	3⅛	50	16	26	3⅛

Metric Units.

	305 meters.				914 meters.				1,524 meters.				3,018 meters.			
mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	Mm.
0.794	305	102	203	28.58	305	102	203	28.58	305	102	203	28.58	406	102	254	28.58
1.588	305	102	203	28.58	305	102	203	28.58	406	102	254	28.58	406	178	305	28.58
1.984	305	102	203	28.58	406	102	254	28.58	406	178	305	28.58	406	254	203	28.58
2.381	305	102	203	28.58	406	102	254	28.58	406	178	305	28.58	406	254	203	28.58
2.778	406	102	254	28.58	406	178	305	28.58	406	254	203	28.58	457	254	203	28.58
3.175	406	102	254	28.58	406	178	305	28.58	406	254	203	28.58	610	254	254	28.58
3.572	406	178	305	28.58	406	254	203	28.58	610	254	254	28.58	610	406	254	53.98
3.969	406	178	305	28.58	406	254	203	28.58	610	254	254	28.58	610	406	254	53.98
4.763	457	178	305	53.98	457	254	203	53.98	610	254	254	53.98	610	406	254	53.98
5.556	457	178	305	53.98	457	254	203	53.98	610	254	254	53.98	813	508	406	79.38
6.350	457	254	254	53.98	610	254	254	53.98	813	457	406	53.98	914	560	457	79.38
7.938	457	254	254	53.98	610	254	254	53.98	813	457	406	53.98	914	560	457	79.38
8.731	457	254	203	53.98	813	406	406	53.98	813	508	406	79.38	1,270	406	660	79.38
9.525	457	254	203	53.98	813	406	406	53.98	813	508	406	79.38	1,370	406	660	79.38

In making racks for the above reels allow a 4-in. or 102-mm. greater width than the traverse specified above.

3N12—Specifications for Sheet Aluminum

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. (*a*) Two grades are recognized:

	Per cent.
Standard No. 1, aluminum	not less than 99.00
Standard No. 2, aluminum	not less than 98.00

Analysis.—(*b*) Samples for analysis shall be obtained from a random sheet, representing each 500 lb. (226.8 kg.) of aluminum, or any lot weighing less than 500 lb. (226.8 kg.), as agreed upon between the seller and the purchaser.

Manufacture.—3. No scrap shall be used except such as shall accumulate at the manufacturer's plant from material of the same composition and of their manufacture.

Workmanship and Finish.—4. All sheets shall be sound, flat, free from buckles, seams, discoloration, or other surface defects.

Physical Properties and Tests.—*Tensile test.*—5. (*a*):

Grade.	Minimum tensile strength.	Minimum elongation in 2 inches (50.8 mm.).
Soft-annealed	12,000 pounds per square inch (8.44 kg./mm.²)	30 per cent.
Half-hard	18,000 pounds per square inch (12.65 kg./mm.²)	10 per cent.
Hard-rolled	22,000 pounds per square inch (15.47 kg./mm.²)	2 per cent.

Bend test.—(*b*) Soft and half hard sheets shall withstand being bent double in any direction over a pin having a radius equal to the thickness of the sheet without cracking.

Selection of Test Specimens.—6. Test pieces shall be cut from random sheets representing each 500 lb. (226.8 kg.) of aluminum or any lot weighing less than 500 lb. (226.8 kg.) as agreed upon between the seller and the purchaser. Test pieces may be used for purposes of analysis as under paragraph 2 (*b*).

Dimensions and Tolerances.—7. Tolerances on all sheets shall be as follows:

Thickness, American Wire Gage (B. & S.).	Tolerances. Inch.	Tolerances. Millimeter.
10–11	0.003	0.08
12–14	.003	.08
15–17	.003	.08
18–20	.002	.05
21–23	.002	.05
24–26	.002	.05

Digest of the Foreign Aeronautical Press

Aeronautics (London), September 26, 1917

Aircraft Industrial Research Association Formed.—The Society of British Aircraft Constructors decided to form a Research Association for the aeronautical industry in accordance with a recommendation made by the Department of Scientific and Industrial Research. That recommendation provides for the formation by industries of associations devoted entirely to technical and scientific research work capable of benefiting the industry. These recognized Research Associations must both in their constitution and Board of Management be approved by the Government. In the first five years of their life they are entitled if necessary, to receive a subsidy from the Government up to an amount not exceeding pound per pound of the funds subscribed by the industry itself, for which purpose a sum of one million pounds has been allocated to the department in question.

If a time period has been imposed for the grant of the subsidies, this is no doubt owing to the reasonable view that, as the beneficial results accruing to the industry directly or indirectly owing to an organized program of research work, become apparent, that industry will be only too anxious to continue to finance its Research Association, and will come to look upon funds so subscribed as a profitable financial investment. It is in order to emphasize this view of the matter that the Government has agreed that contributions by firms to the funds of their industrial Research Association shall be allowed as a deduction for income tax and excess profit duty purposes.

A draft memorandum of association for such research associations has been prepared by the Department of Scientific and Industrial Research. This memorandum provides that the objects for which the Research Association is established are:

(a) To promote research and establish laboratories.
(b) To accept grants of Government money, etc.
(c) To employ technical advisers.
(d) To establish museums, libraries, etc.
(e) To investigate inventions, etc., for the purpose of the industry.
(f) To cooperate with other associations.

What useful purpose, it may be asked, can this Research Association serve beyond that already fulfilled by the aeronautical branch of the National Physical Laboratory which, be it noted, is now also controlled by the Department of Scientific and Industrial Research? The answer can be given with confidence.

In the first place, the work of the N. P. L., valuable beyond all praise, has been purely scientific and in no sense industrial. In one sense, indeed, it has been too scientific, for it has been concerned over much with the minutiæ of scientific accuracy to the neglect of wider problems. It has tended rather to hunt down possible margins of errors to one per cent, with the utmost painstaking care where five per cent was adequate for commercial purposes. But the aircraft industry has for it no existence. And if we built solely on N. P. L. data we should no doubt obtain a machine on the verge of theoretical perfection, but it is certain that from a commercial and industrial point of view it would be impossible. Industrial research in the wider sense, therefore, constitutes the first item in the program of the new association.

In the second place there is no gainsaying the fact that the N. P. L. is regarded by private manufacturers and designers or inventors with a certain amount of suspicion. In the matter of the aircraft design it is difficult, if not impossible, to establish proprietary rights in a design or method of manufacture. Consequently the designer of a happy combination of factors, who presented his design for test to this Government institution, had no guaranty that it would not be promptly annexed by the Government without formality or by your leave. In the case of the Research Association controlled by the industry that danger is removed. At best, proprietary rights can be strictly reserved to the designer; at worst, they would go to benefit the whole industry.

Aeronautics (London), October 3, 1917

British Air Supremacy as Illustrated by German Figures.—An official communique is a two-edged sword—it cuts both ways. The German claims of air victories are usually overstated. But let us take them at their face value. Captain Von Richthofen, leader of the famous "circus," also known as Richthofen the First, is reputed to have brought down sixty airplanes; Lieutenant Werner Voss is placed second in the list with thirty-eight opponents to his credit; next comes Lieutenant Wolff with thirty-three, and further down Lieutenant Richthofen "Secundus" with twenty-four. Now the last three have been killed within the last few weeks, and the first seriously wounded, is definitely out of action. So that, if the German claims are correct, we and our Allies have won a considerable success.

Far be it from us to despise the German aerial effort. Frankly, it is superb. The organization of the German Air Service is excellent; its mechanical resources are plentiful; its men—those of the "old gang" that are left to them—are fine and resourceful fighters. Throughout, they are far more methodical than our men. Nevertheless, we shall beat them, but only with a mighty effort. And a change from khaki to navy-blue or grey won't do the trick. Above all, we require organization in our men, and especially material. The more so because the German resources are dwindling fast in the air as upon land. Hitherto recruits for the Air Service have been selected with extreme care, but recently an order has gone forth that all requests for transfer to the Flying Corps are to be accepted irrespective of personal qualifications. In particular, cavalry officers are urged to join the Air Service.

The fighting scout mainly used by the Germans at present is the type D3 Albatros, engined with 170 hp. Benz. Her best flying speed is in the region of 125 miles an hour, her climb 20,000 ft. in 22 minutes. A 200 hp. Benz-Albatros is on the stocks, and will shortly make its appearance.

Meanwhile, it appears from a reliable French source that all is not well with the twin-engined Gotha. Its performance is certainly good—a ceiling of 20,000 ft. with fuel for five hours and getting on for half ton bombs—but the landing speed is most indifferent (as might have been expected) and is stated to be the cause of numerous accidents.

Aeronautics (London) October 10, 1917

The Policy of Reprisals.—On Oct. 4, at a luncheon tendered to him by the Association of Chambers of Commerce, General Smuts lined out the British Government's newly adopted policy toward air reprisals as follows: Our air policy has been entirely different from that of the enemy. It has been our main and constant object to obtain and maintain military predominance in the air on our various fronts and to bomb only military objectives such as railways and railway stations and junctions, aerodromes, docks, depots and military and naval bases of all sorts. Since July 31 we have been fighting a great battle in Flanders, which has meant a great and simultaneous struggle in the air. In the Battle of the Somme we mastered the enemy completely in the air. Taught by this, he has made great efforts to prevent us doing this again, and has concentrated a great many airplanes against us from other fronts. We started bombing with heavier than air machines. The enemy has followed us, but has not caught up. He bombs the French towns and the troops behind the lines, and does far more damage there and inflicts far heavier loss than we have suffered in England, but again we bomb him much more and cause him far greater loss behind his lines.

Last month our naval and military airplanes dropped 207 tons of bombs behind the enemy's lines. In the same period he dropped four and one half tons of bombs on London. In that month we bombed him on twenty-three days and nineteen nights, chiefly attacking his aerodromes, and in particular the great aerodromes at St. Denis, Westrem and Gontrode, where the Gothas live, setting hangars and sheds on fire, and as photographs prove, damaging his machines and pitting his aerodromes with shell holes. We also bombed his billets, trains, transports and railway stations, causing him very heavy losses. In London during last month our total air losses were fifty-one killed and 247 injured. During the first nine months of this year the losses from air raids were 191 killed and 749 wounded, as against 487 persons killed and 14,104 injured in traffic accidents in the Metropolitan Police area.

Hitherto we have as far as possible avoided using the airplane as an engine of destruction and terrorism against the civilian population of the enemy countries. The enemy, on the contrary, has from the very beginning devoted his aircraft to all kinds of non-military uses. First with the Zeppelin, and now with airplane, he is conducting a campaign of ruthless, pitiless terrorism against undefended towns and populous centers which have no direct military value. Indeed one can but come to the conclusion that the Germans in their raids are avoiding objectives of direct military value. Invariably they attack the residential districts of London, not its outside arsenals or fortifications, or even its docks, still less places of direct military importance, except very occasionally, and as it were by mistake. I imagine their object in all this calculated brutality has been twofold; first to strike terror into the hearts of the civilian population, and to destroy their morale by every means, however abominable; secondly, to force us to take machines back from the front to the defense of London and other home areas.

In both objects they have miserably failed. There is not in London or in the country a single machine taken back from the front for home defense, and the national temper instead of weakening it, on the contrary, hardening under the strain of these terrors and abominations. Meanwhile a very bitter temper is growing up in this country, a temper with which any Government will have to reckon seriously in settling its future air policy. And I am sure it is not the people of this country who will be to blame for any further intensification of the horrors of war. It is a mistake to think that hitherto we have not had any means at all of carrying our aerial warfare into the enemy country. But we felt that we should rather prepare for an air offensive on a large scale and we were anxious also to avoid adding further horrors to this war, already the most cruel in the history of the world. But we are dealing with an enemy whose Kultur has not carried him beyond the rudiments of the Mosaic Law, and to whom you can only apply the maxim of "an eye for an eye and a tooth for a tooth." On that principle we are now most reluctantly forced to apply to him the bombing policy which he has applied to us, and I am afraid the Government has no longer any choice in the matter.

Flying (London), October 17, 1917

The New Gothas.—The bomber airplanes, which the enemy has recently sent against the British Isles, appear to be Gotha machines of a new type. They are said to be equipped with four Mercedes engines of 260 hp. each and carry fuel for 10 hr. Their crew is made up of five men, two pilots, two gunners and a captain, who controls the radio apparatus.

The Aeroplane (London) October 3, 1917

The Sopwith Triplane.—In the August issue of the *Deutsche Luftfahrer Zeitschrift*, Robert Eisenlohr, a well-known aeronautical writer, describes the British Sopwith triplane as follows:

Among the new machines which the war has created, the Sopwith triplane holds a special position, since it is the first triplane to be employed for practical purposes. This type had become obsolete since the little successful experiments of Hans Grade in Germany, of A. V. Roe in England, and of Goupy in France. However, after Curtiss produced, in 1916, a triplane, Sopwith too turned toward this type of machine.

The principal advantage claimed for the triplane is the small span, which it can be given on account of the additional lifting area furnished by the third plane, whereas the increased head resistance is neutralized by the use of simplified struts and wiring. The lighter loading of the planes also permits use of lighter spars and a comparatively wide overhang.

The triplane arrangement may also afford the pilot a better range of vision, as the middle plane is level with his head, and the small chord of the upper and lower planes hides less than the larger wings of a biplane.

The Sopwith triplane has a small dihedral, but no retreat is embodied in the wings. The planes are staggered and all carry ailerons. The body is of rectangular section and carries in front a 110 hp. Clerget rotary engine which is housed in a cowl overhanging the body.

This machine is produced both as a single-seater and as a two-seater. On both models a fixed machine gun is carried in front of the pilot, but on the two-seater machine the observer, who sits behind the pilot, is provided with another machine gun which is mounted en barbette.

CHARACTERISTICS

Span, all three planes	8.00	m.
Chord, all three planes	1.00	m.
Gap, upper and lower	0.90	m.
Overall length	5.10	m.
Overall height	3.00	m.
Span, elevator	3.00	m.
Surface area, planes	27.00	sq. m.
Weight, fully loaded	670.00	kg.

A Novel Propeller.—A novel type of propeller has recently been introduced by Mr. Bourke, which is grooved to prevent slip.

For this purpose the blades of the airscrew are provided on both faces with transverse ribs, the intervening space being shaped in the form of concave grooves. The latter are not, however, carried through the whole width of the blade, but stop not far from the leading edge. The inventor claims that in rotating, the rarefaction of the air within the grooves creates, on the forward face of the blade, a suction effect which increases the tractive effort. On the after face of the blade similar grooves discharge the air in the direction of the trailing edge of the blade thus increasing the rearward thrust.

Espana Automovil (Madrid), September 30, 1917

Spain Creates Naval Flying Corps.—A royal decree issued on Sept. 20 creates a Naval Flying Corps which will be directly attached to the Ministry of Marine. A naval flying school will be established at Cartagena and a Government factory is to be organized for the production of naval aircraft. As soon as the circumstances will allow for it, air stations will be created at the principal naval bases at Cadiz, Ferrol and Cartagena, and later on at the second class bases of Galicia and Mahon (Baleares).

THE ZEPPELIN L-49, WHICH WAS CAPTURED INTACT IN FRANCE

(C) *Underwood & Underwood*

News of the Fortnight

American Flying Records Broken

A remarkable flight from Chicago to San Antonio, Tex., was completed by an L. W. F. biplane at 10 a. m., Nov. 13, during which several American records for speed and distance were shattered.

An L. W. F. machine, piloted by H. W. Blakley, left Chicago on Sunday, Nov. 11, in a driving rainstorm. Blakley flew from Chicago to Muskogee, Okla., about 650 miles, at an average speed of 120 miles per hour. The distance, from Muskogee to Dallas, Tex., was made at an average speed of 130 miles per hour.

The great bursts of speed of the L. W. F. machine were made with the eight cylinder 210 hp. aluminum engine manufactured by the B. F. Sturtevant Co. of Hyde Park, Boston, Mass. Detailed reports of the performance of the engine during the flight are not yet available, but the flight indicates that another American engine of great power, speed and endurance has been successfully developed and tried out.

The L. W. F. machine used in the flight was one of the standard models produced by the L. W. F. Engineering Co.

All-American Fighting Airplane Tested

The first fighting airplane, wholly made in America of American materials, has taken the air in successful test flights. In making the fact known officials of the Aircraft Production Board said few changes in the design of either the plane or the Liberty Engine were believed necessary, and that production in quantity of the fighting machines soon would be in progress in many factories.

By the first of the new year it is expected that the aircraft program will be well under way, and by July 1 the Government expects to be able to supply any demands of its Allies. Machines, which United States forces in Europe will need when Spring comes, are being built abroad.

American engineers expect that the aircraft program can be made whatever the Allies require. Originally, the figures were set at 50,000 engines and 22,000 planes by July 1.

Council of National Defense Moves

The temporary office building now occupied by the Council of National Defense, its advisory commission, and the subordinate committees of both bodies, including the War Industries Board at Seventeenth and C Streets, Washington, D. C., contains slightly in excess of 100,000 sq. ft. of space, with heating, toilet, and fire-protection facilities customary in office buildings.

The construction required over a million board feet of lumber, and the maximum labor employed was 450 workmen and mechanics of all classes. The cost of the completed structure will be under $225,000.

The new building will house upward of 600 persons in the personnel of the Council and its subordinate bodies. Aside from this, office space has been given to the representatives of the purchasing commissions of the Allied Governments.

Election of Aero Club of America

At the annual meeting of the Aero Club of America, held at the club house, 297 Madison Avenue, New York, on Nov. 12, the following officers were elected: Alan R. Hawley, president; Henry A. Wise Wood, first vice-president; Godfrey L. Cabot, second vice-president; Rear Admiral Bradley A. Fiske, U. S. N., third vice-president, and Jerome Edwards, fourth vice-president. Governors—Class A—term expiring 1921, Cortland F. Bishop, Alan R. Hawley, James E. Miller and Henry A. Wise Wood; term expiring 1918, Rear Admiral Fiske. Governors—Class B—Albert B. Lambert, Henry B. Joy, Godfrey L. Cabot, George M. Myers, John Hays Hammond, Jr., Alberto Santos-Dumont, Brigadier General Robert K. Evans, U. S. A., Max C. Fleischmann, treasurer, and Charles E. Warren.

Italian Makes a Fast Flight

Lieut. Giuseppe Adamoli of the Italian Royal Flying Corps set a new record for long distance speed flying on Nov. 1, when he traveled from Langley Field, Norfolk, Va., to Hazelhurst Field, Mineola, N. Y., a distance of 336 miles, in two hours and twenty-five minutes. Adamoli used a one-seated Macchi seaplane for the flight. He left Norfolk at 10.30 o'clock in the morning and reached Mineola at 12.55 o'clock in the afternoon. Adamoli's seaplane carries two machine guns.

Civil Air Services Planned

The Daily Express of London announces that as soon as the war is ended aerial navigation plans which are being drawn up by the Civil Aerial Transport Committee, appointed by the British Government will be put in operation step by step, and the ends of the world will be brought together by long-distance airplane service.

The *Express* says it has information that if favorable weather conditions prevail it is likely that the Atlantic will be crossed by an airplane before the end of this year. It understands that the flight will be made by way of the Azores, so that the journey may be broken.

The bridging of the Atlantic by airplane, it says, will be only the beginning. Plans are being laid for regular air service, not only to America, but to India, South Africa, and Australia. If they are carried out Melbourne will be brought within eight and one-half days of London; India, three days, and Cape Town, four or five days. The bee line to Cape Town would of course cross the Sahara, but the winds of the desert raised obstacles to the route, and the route chosen is by way of Malta, Cairo, Khartoum and Victoria Falls.

The *Express* says that the machines, which will be used for these world journeys will be of the type developed by Handley Page, will travel 200 miles an hour, will have multiple engines to avoid the necessity for descending if one engine gives out, will carry four or five passengers, and will be able to cover about 3,000 miles in 15 hours. Two pilots will take turns at the wheel. There will be comfortable inclosed quarters and the journey will not be more exhausting than a railway trip of similar duration.

Liberty Engine Reported Satisfactory

It is said that influences have been at work in an organized effort to belittle the qualities of the Liberty engine and to create in the minds of the public the impression that a foreign engine would be adopted in its place.

Government officials declare that the Liberty engine has stood successfully every test that has been applied to it, including actual use in airplanes, and its performances have left nothing to be desired.

A number of contracts for the manufacture of the Liberty engine have been let and the work is progressing so satisfactorily the first deliveries will be about Dec. 1. The number that will be available at that time is withheld for reasons of public policy, but assurance is given that it will be sufficient to meet the immediate needs of the aircraft program and that the output will increase with each month.

The program of the Aircraft Production Board has involved the expansion of many factories heretofore engaged in the manufacture of automobiles, as well as the increase in size and number of factories making aircraft alone. This expansion has attracted thousands of workmen to the localities of these plants, and the resulting increase in population has made the housing of the men and their families one of extreme difficulty.

Maj. Gen. Biddle, Assistant Chief of Staff

The Secretary of War authorizes announcement of the appointment of Maj.-Gen. John Biddle, formerly president of the War College, as Assistant Chief of Staff to fill the vacancy caused by the appointment of Gen. Tasker H. Bliss as Chief of Staff.

Major-General Biddle is a native of Michigan and was born Feb. 2, 1859. He was appointed from that state to the Military Academy Sept. 1, 1877, and graduated with the class of '81. He returned to the academy as superintendent in 1916 and served approximately a year in that capacity. He was appointed a brigadier general and assigned to the line a few months ago.

Restrict Ball-Bearing Trade

The American consul general at London has cabled as follows:

Minister of Munitions from Nov. 1 forbids the manufacture, sale, and delivery of ball bearings or roller bearings or any part thereof except under license. Applications should be addressed to the Director of Ball Bearings, Ministry of Munitions.

Census of the Army

Under the direction of the Committee on Classification of Personnel in the Army, headed by Prof. Walter Dill Scott, the War Department is taking a census of the selected men as they arrive at the training camps. This army directory writes practically a life history of every man selected for service. It shows his education, business experience, the amount of salary received in civil life, proficiency in any trade, aptitude for special work in The Army, ability to speak foreign languages, and even a statement of the soldier's ability to fit into diversions and entertainment.

Secretary Baker makes the following comment on the desire of the selected man to get into the thick of action:

"In those camps, each man is asked: 'What do you want to do?' I have had reports from five or six of the largest camps, and they show that the majority answered in effect: 'I don't care what I do just so I get to France among the first!' The next question asked them is: 'What branch of the service do you prefer?'

"Now, one who didn't know America would expect them to say: 'Well, I have been working in a store'; 'I have been a hand on a farm'; 'I have been a mechanic'; 'I have been a clerk'; 'I don't know much about guns and cannon, perhaps some of the non-combatant places is the place where I can render the best service.' But what is the fact? These sons and brothers, drawn out of life by selection—more than one-third have asked to go into the infantry service. The next choice is the light artillery; the next is the heavy artillery service; the next is the aviation service. So that what they asked for in a tremendously predominating majority of instances is, not the non-combatant service, for which their previous experience might well qualify them, but the fighting branch, so that they can take the risk of fighting for their country with the real weapons of war! The boys at the front and getting ready to go are all right! Our nation need have nothing but mounting pride at the spectacle they present."

The committee has put into operation a comprehensive plan for classifying the men as they undergo training. Each company commander becomes practically a census taker. He distributes question cards among his men. The buff copy of this card is preserved with the company records after it has been filled out. The white original is sent to division headquarters, where a division personnel officer studies the answers given and classifies the selected man according to his capabilities.

One day's examinations at Camp Upton for "preference as to branch of service," showed: Infantry, 722; cavalry, 6; field and heavy artillery, 427; coast artillery, 52; engineers, 183; signal corps and aviation, 123; medical corps, 53; quartermaster corps, 561; ordnance, 17; machine guns, 7; trains, 4; veterinary service, 1.

General Henderson Praises U. S. Aircraft Program

Maj.-Gen. Sir David Henderson, who is retiring as head of the British Air Board to undertake an important "special duty," in an interview with the Associated Press, praised the American war program, but warned against the danger of overdoing standardization in aircraft. He expressed the belief that the American public should be prepared for "fairly severe" losses in air training.

"I shall not say much to you about the plans of the British air service for the immediate future," Sir David said. "That would be giving information that the enemy is very anxious to obtain. The Germans are acutely alarmed over the preparations that the Entente Allies are making for the air war next year. They are under no illusions about it and they are bending every effort to counter it by a stupendous program on their own side. But we have had the upper hand of them in the air from the very beginning, and feel sure, especially with the help of the United States, that our mastery will grow stronger notwithstanding all their efforts.

"The British Flying Corps is from seventy to a hundred times larger today than at the start of the war, and we have made this tremendous augmentation at the same time that we have been carrying on a war that involved heavy losses and continual replacements from the very first day.

"As to the production of a standard type airplane, there still is some difference of opinion. Certainly there is great danger in overstandardization. If you want the best type you must be continually improving and changing. The question the air commander must ask is 'How long can you afford to go on with a particular type of machine?' and 'Whether it is likely soon to be superseded by a better type?'"

Germany Preparing to Raid America

Dr. Lyman B. Powell, president of Hobart College, who has returned from the war zone, where he had unusual opportunities to observe conditions, is quoted as saying that the Germans are planning to raid the American coast with their aircraft within the next six months. To accomplish this, he said, they are now engaged in building a fleet of huge airplanes which could travel from 100 to 200 miles an hour, and could rise to a height of 20,000 ft., if necessary.

"It is a mistaken policy," said Dr. Powell, "to suppress or minimize the seriousness of the situation. The American public is not even half awakened to the havoc that has been wrought by the airplanes in England. The casualties are much greater than the people over here have been led to believe. Since May 1, 2,000 men, women and children have been maimed or killed in London by air raids.

"It is just such a peril that we are facing in this country, but we will not realize it. French military experts have informed me that the Germans are building airplanes on such a huge scale that the Allies will have to work ten times as fast as they are to keep up with them. In the first place, they are devoting themselves entirely to the construction of biplanes that will be capable of operating from a height of 20,000 ft.—airplanes, furthermore, that will be able to carry at least two tons of bombs.

"The Germans intend to settle this war with the airplane. What is more, they intend to carry the war right to our doors with a fleet of huge seaplanes, which will be able to travel from 100 to 200 miles an hour. It is about time that the people here knew the truth about these things. Thus far the western line and the British fleet have stood between America and the fate of Belgium. But airplanes that can rise to a height of 20,000 ft. and travel from 100 to 200 miles an hour will overcome even those barriers, and America, unless she is awake, unless she is prepared, is from that moment at Germany's mercy."

The Standard Aircraft Corp. Formed

The Standard Aircraft Corp. was granted a charter by the Secretary of State of New York on Oct. 31 with an authorized capitalization of $5,000,000. The office of the new company is in the Woolworth Building, New York City, and its plant is located at Elizabeth, N. J.

The company is formed for the purpose of manufacturing aircraft and other contrivances and devices for aerial navigation, either from land or water. The stockholders are Harry B. Mingle, Llewellyn Park, West Orange, N. J.; Charles H. Day, Plainfield, N. J., and Daniel L. Meehan, Jr., New York City.

President Mingle states that the new corporation will be utilized entirely for production work, while the Standard Aero Corp. will devote its organization and plant to experimental and engineering work.

Rubber Company's Aeronautical Course

The Goodyear Tire & Rubber Co., Akron, Ohio, has added a course of aeronautics to the curriculum of its factory school.

Only those who have had a high school course or its equivalent will be permitted to enter the new class. A small tuition fee to cover necessary expenses for experimental equipment and the like will be charged.

The school is the result of a suggestion by Goodyear men, who pointed out that a company so largely engaged in the manufacture of aircraft should devise some method of teaching its own employes the fundamentals of aeronautics.

Cold Light Mfg. Co. Moves

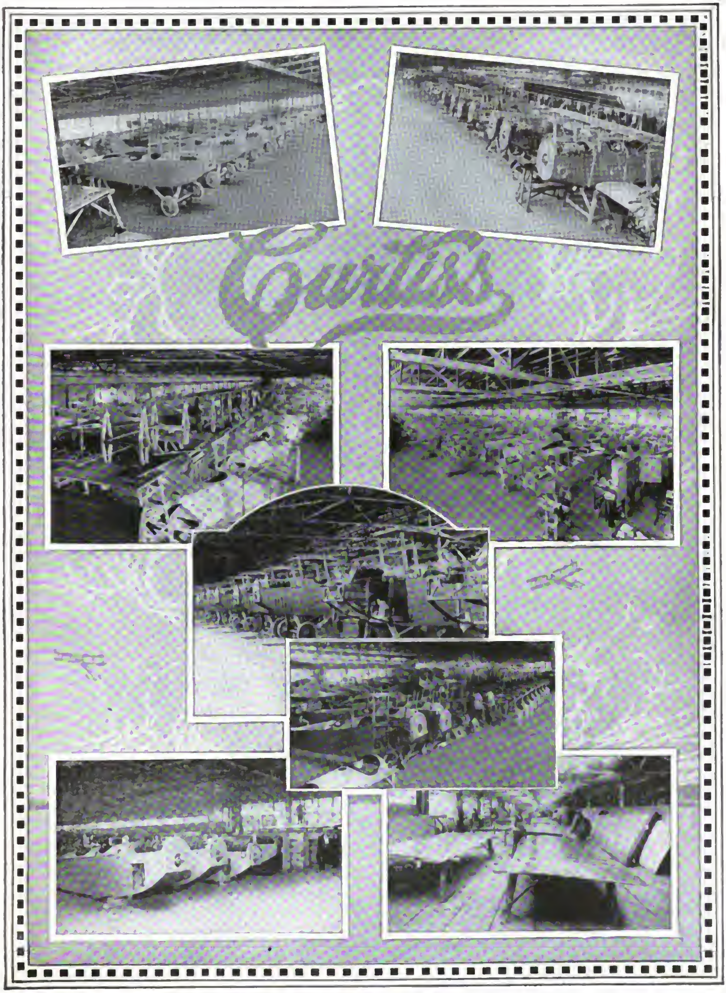
The Cold Light Mfg. Co., Inc., has found it necessary, on account of the large demand for its products in the Eastern States, to move its general offices and studios from Denver, Col., to 558 West One Hundred and Fifty-eighth Street, New York City. Its Western studio will be maintained to supply that territory.

Succeeds Schweizer & West

The West Woodworking Co. has succeeded the Schweizer & West Mfg. Co., 308-324 North Ada St., Chicago, Ill., in the manufacture of Westmore Splitless propellers. Charles L. West is president and manager of the new concern.

Curtiss Experimental Plant Nearly Ready

The new Curtiss experimental plant near Garden City, N. Y., is nearly ready. The main building is 200 by 300 ft. and is of the reinforced concrete type of construction.



THE CURTISS AEROPLANE COMPANY, BUFFALO, N. Y.
America Trans Oceanic Company, 280 Madison Ave., New York City, New York Agents

TURNBUCKLES

We Manufacture the Following Type Aeroplane Turnbuckles

Standard Type

No. 1 Female, Short A-1518 No. 2 Female, Long A-1520
No. 1 Male, Short A-1522 No. 3 Male, Long A-1524

Curtiss Type

326 Short, Male 327 Long, Female
326 Short, Female 327 Short, Female
326 Long, Female 328 Long, Female
327 Long, Male 329 Long, Female

The Dayton Metal Products Company

DAYTON, OHIO, U. S. A.

The Eyes of the Guns

THE Great War has shown clearly that the observing airplane is not all-sufficient for the artillery.

The needs of the guns must often be served by more unwavering eyes.

The stable and readily available kite balloon is an indispensable eye of the guns, and its further development is as imperative as the perfection of any of the other aerial services.

Before the new Goodyear Kite Balloon was tested and approved, the problems demanding better solutions were the primary ones of *material* and *stability.*

In both, Goodyear has made a decided advance.

Our work for many years on balloons of any size and every type has put the former on a standardized basis, which simplifies specification and makes definite the direction of further progress.

The latter demanded newly directed labor in design and ungrudging research in the field — in our own country and abroad.

The result is the new Goodyear Kite Balloon.

Even as years of achievement have justified its Goodyear fabrics, exacting tests have justified its reinforced tail cups and the design of every part.

The Goodyear Tire & Rubber Company, Akron, Ohio

GOODYEAR
AKRON

Airplane Parts!
Immediate Delivery!

Fortunately, the present crisis finds the Standard Parts Company ready to help you greatly in the rush demand for airplanes.

We are able to ship immediately necessary parts for the construction of airplanes the government must have in a hurry.

You can order from us at once such parts as:

Steel Tubing
Stabilizer Tubes
Push Rod Tubes
Tubing formed per B/P's and straight tubing in diameters ranging from ¼" to 2½", 14 gauge (.083") to 22 gauge (.028")

Special Rod Assemblies
Rims of all sizes to government specifications
Bearings
Tire Rims
Springs
Forgings.

For years we have made oval and "D" shaped tubing for the Curtiss Airplane Co.

Let us help you make your estimates.

Write us for information at once before you submit your bids for airplane construction.

If you have already made a contract, wire or write us immediately and take advantage of the instant service we can render you.

The factories of this company have been among the foremost in the field of motor-driven vehicles since the earliest days of the industry. Our engineering department and our laboratories are among the most complete in the world.

The Standard Parts Company, Cleveland, Ohio, U. S. A.

Famous for Stanweld Rims, Tubing, etc., Perfection Springs, Bock Bearings, Axles, Perfection Heaters, Forgings, Hubs, etc., etc.

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CATALOG NO. 96 OF

"Hardware, Tools and Supplies"

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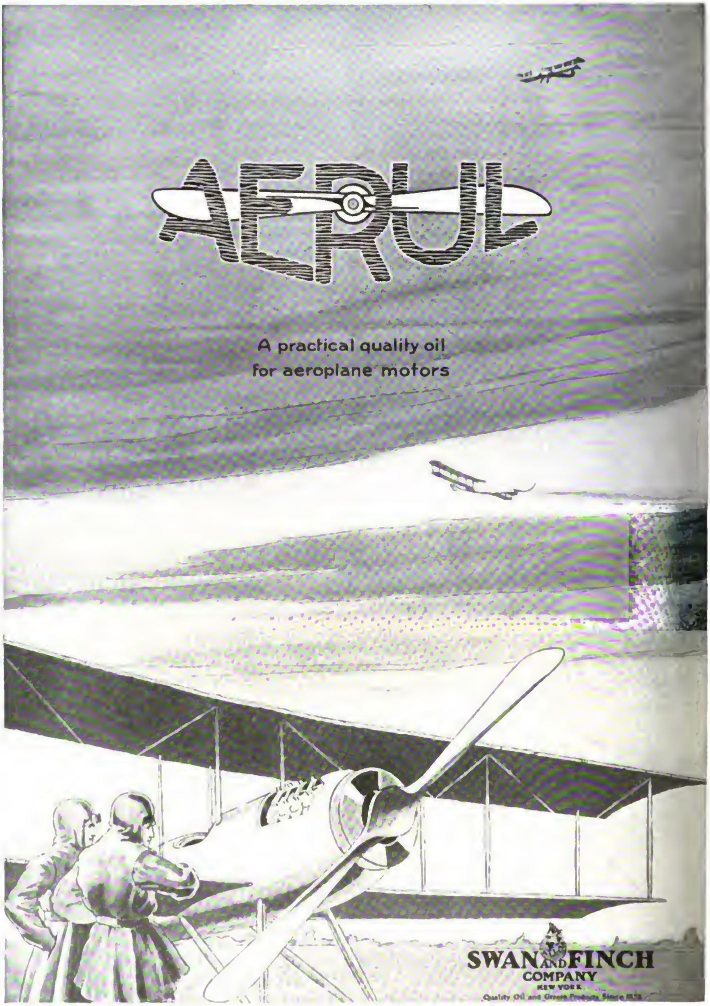
OUR NO. B CABINET MAKERS' WORK BENCH
BRASS, WOOD AND MACHINE SCREWS

WE INVITE CORRESPONDENCE WITH THOSE INTERESTED IN THESE ITEMS

HAMMACHER, SCHLEMMER & CO.

NEW YORK, SINCE 1848 **4th Avenue and 13th Street**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A practical quality oil
for aeroplane motors
SWAN AND FINCH
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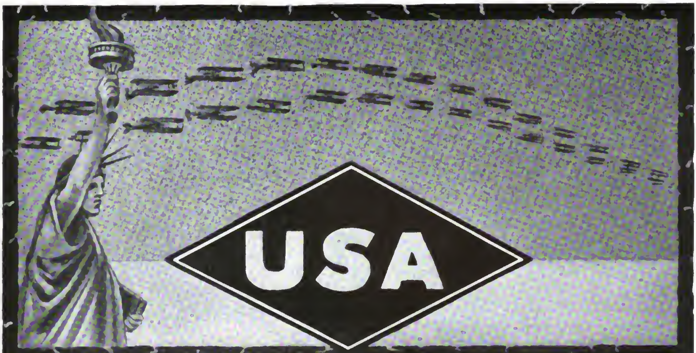
NEW YORK
Quality Oil and Grease Products Since 1853



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INCREASE SPEED—DECREASE WEIGHT

We also manufacture

ALUMINUM INGOTS, PURE AND ALLOYS, RODS, GRANULES. ALUMINUM SOLDER, GUARANTEED TO GIVE SATISFACTION. BABBITT METAL — SOLDER — PIG METALS.

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Quality Right

United Smelting & Aluminum Co., Inc.

General Offices:—NEW HAVEN, CONN.

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CRANKSHAFT QUALITY

Stands out as the one requirement today of the builder of

AIRCRAFT AND HIGH DUTY ENGINES

Experience only can produce a product to equal these demands.

Wyman-Gordon Company for many years, in their Research, as well as their Manufacturing Departments, have been developing along the lines that make them today able, without experiment, to supply crankshafts of

UNQUESTIONED RELIABILITY

Every stage in the production of a Wyman-Gordon crankshaft is subjected to rigid inspection and tests guaranteeing a high metallurgical quality.

Behind this perfect product is a perfect service.

Prompt attention to all orders and deliveries without delay.

WYMAN-GORDON COMPANY
WORCESTER, MASS.

Save Production Time

The unusually comprehensive equipment of standard tools is one important factor that should influence you, when adding to your equipment, to install.

Warner & Swasey
Turret Screw Machines

The available tool equipment is the most comprehensive ever provided for any turret screw machine. Without waiting for special tools to be designed and made, you can reduce production time—in some instances by half.

And the machines themselves are standard in their class, representing the maximum in production and accuracy.

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CLEVELAND, OHIO, U. S. A.

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Detroit Office—Ford Bldg.
Boston Office—Oliver Bldg. **Buffalo Office**—Iroquois Bldg.
Chicago Office and Show Room—618-622 Washington Blvd.

FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Allied Machinery Company, Paris and Turin. Van Rietschoten & Houwens, Rotterdam. Yamatake & Co., Tokio. Benson Brothers, Sydney and Melbourne. A. Asher Smith, Sydney. A. R. Williams Machinery Co., Ltd., Toronto, St. John, Winnipeg and Vancouver. Williams & Wilson, Ltd., Montreal.

The Buyer's Interest in Wasteless Advertising

BUYERS who appreciate that waste in selling must eventually be passed on to them in some form, are paying more and more attention to the sales methods of the concerns seeking their business.

The extravagant use of space in publications of general circulation, to advertise a commodity or a service appealing chiefly to a certain well-defined class, is not only poor judgment, but *it is an economic waste.*

Can you imagine an intelligent salesman, with a proposition for a steel mill or a dry goods store, calling at every office in town in an effort to locate a prospect? How needlessly wasteful to adopt similar methods in advertising, which is simply an improved means of accomplishing certain necessary steps of a sale.

On the other hand, the seller who uses the business papers reaching *only* the class interested in his message, is employing the most direct, efficient and economical method of getting in touch with prospective buyers.

Properly used, the good business paper bears the same relation to the sales department, that an improved machine does to the production department. Better selling methods go hand in hand with better manufacturing methods.

To encourage wasteless advertising, the most efficient modern means of bringing buyer and seller together, there is every reason why the discriminating buyer should give preferred consideration to the concern that tells its business story in the buyer's own business paper.

Ask this office anything you want to know about Business Papers or Business Paper Advertising.

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Technical and Class Publications

Headquarters 220 West 42nd Street
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American School Board Journal
Architectural Record
Aviation & Aeronautical Engineering
Boot & Shoe Recorder
Brick & Clay Record
Buildings & Building Management
Bulletin of Pharmacy
Canadian Grocer
Canadian Railway & Marine World
Cement World
Clothier & Furnisher
Coal Age
Concrete
Domestic Engineering
Drygoodsman, The
Dry Goods Economist
Dry Goods Reporter
Electrical Review & Western Electrician
Electrical Merchandising
Electrical World
Electric Railway Journal
Electric Traction
Embalmer's Monthly
Engineering & Mining Journal
Engineering News-Record
Farm Machinery—Farm Power
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Industrial Arts Magazine
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Iron Age
International Trade
Lumber Trade Journal
Lumber World Review
Manufacturers Record
Manufacturing Jeweler
Marine Engineering
Metal Worker, Plumber & Steam Fitter
Metallurgical & Chemical Engineering
Modern Hospital
Motor Age
Motor World
National Builder
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Shoe & Leather Reporter
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Tea & Coffee Trade Journal
Textile World Journal
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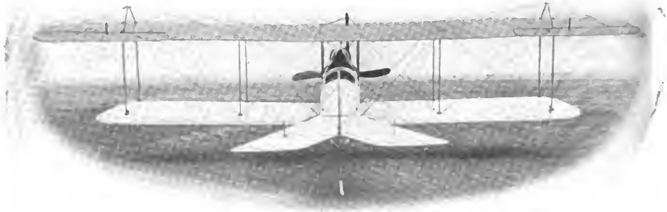
Cleveland............950 Leader-News Building
Detroit...................1512 Ford Building
Kansas City............308 R. A. Long Building
Los Angeles *(Pierson, Roeding & Co., Agents)*
494 Pacific Electric Building
New York......................120 Broadway
Philadelphia.........1216-1218 Widener Building
Rochester...............1112 Granite Building
San Francisco (*Pierson, Roeding & Co., Agents)*
731 Rialto Building
Seattle *(Pierson, Roeding & Co., Agents)*
523 Colman Building
Washington......509 Metropolitan Bank Building

Send inquiries regarding aluminum in any form to nearest Branch Office, or to General Sales Office



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BUILDERS OF AIRCRAFT

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Contractors to U. S. Government

a counterbalanced aviation crankshaft . . . .

one of the 18 different
models we are now making
for 14 aviation motor companies . . .
reduces vibration and eliminates bearing pressure

We have shipped 55,518 Counterbalanced Crankshafts to October 31, 1917

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AIR PLANE DRY KILNS

We are prepared to design, equip, install and operate according to Aircraft Engineering Division Specification No. 20,500.

I. *Grand Rapids Vapor Process Kilns* (as perfected thru the erection of 2,000 kilns in high class woodworking plants).

II. *Tiemann Humidity Regulated Kilns* (as designed and developed by the Forest Products Laboratory at Madison, Wisconsin).

III. *Tiemann-Grand Rapids Combination Kilns* (combining the scientific points of the Tiemann kiln with the practical experience of the Grand Rapids Veneer Works, subject to operation by either method).

We have designed or equipped kilns for

STANDARD AERO CORPORATION,
DAYTON-WRIGHT AIRPLANE COMPANY,
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CURTISS AEROPLANE & MOTOR CORPORATION,
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Our kiln instruments are in use by (in addition to list opposite)

CANADIAN AIRPLANES, LTD.
THOMAS-MORSE AIRCRAFT COMPANY,
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Submit your drying problem to experts who make a specialty of kiln design and are prepared to furnish and install all equipment and instruments

GRAND RAPIDS VENEER WORKS

Grand Rapids, Michigan
Seattle, Washington

The Taft-Peirce plant is one of the oldest and the most extensive "contract-shops" in the United States. It has been identified with the evolution and initial production of many mechanical developments, each marking a new era in the sphere of human progress—such as the sewing machine, the typesetting machine, the typewriter, the adding machine, the motorcycle and the automobile.

Today it is the largest and best equipped organization of its class in this country for work of the character necessary in the development of aeronautical engines, light machinery parts and special tools.

The advantage of such experience is at the command of concerns whose present production might be materially improved or increased by proper co-ordination.

TAFT-PEIRCE
Woonsocket, R.I., U.S.A.

2003

CRANKSHAFTS, Etc., Will Be Put in Running Balance in My Recently Organized

Laboratory of Dynamic Balance

Centrally Located in This City

All work guaranteed and done an my latest Balancing Apparatus. It appears that a great deal of misinformation is now being circulated with respect to the would-be *simplicity* with which, for instance, a six throw shaft can be balanced, by some self-appointed *experts*. Let me have a shaft balanced in this manner and I will explain the *correct* way of balancing such a shaft.

N. W. AKIMOFF, Builder of Dynamic Balancing Machinery
Office: HARRISON BUILDING, PHILADELPHIA

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of the
HIGHEST QUALITY
for
land and water machines built by constructors able to afford the best. Also gives excellent results and reduces fire risk when used for the last 2 or 3 coats over a cheaper dope

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AMERICAN EMAILLITE COMPANY
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CAPACITY QUALITY
DU PONT

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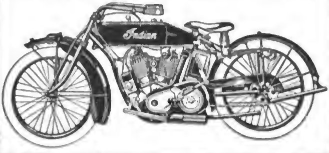

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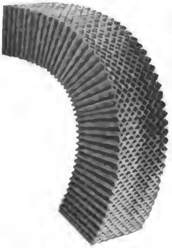

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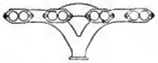

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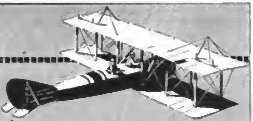

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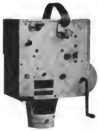

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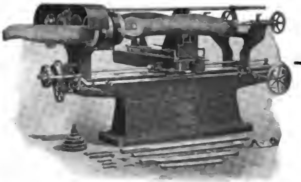

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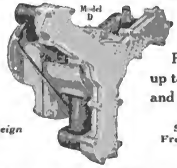

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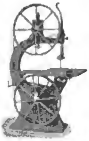

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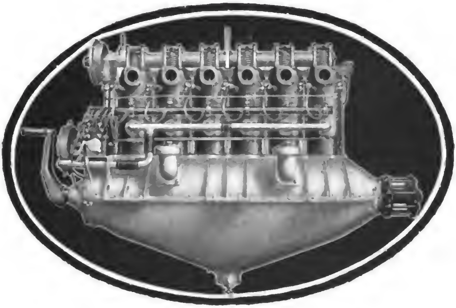

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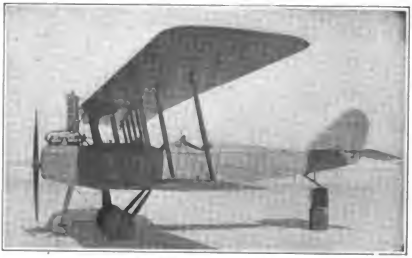

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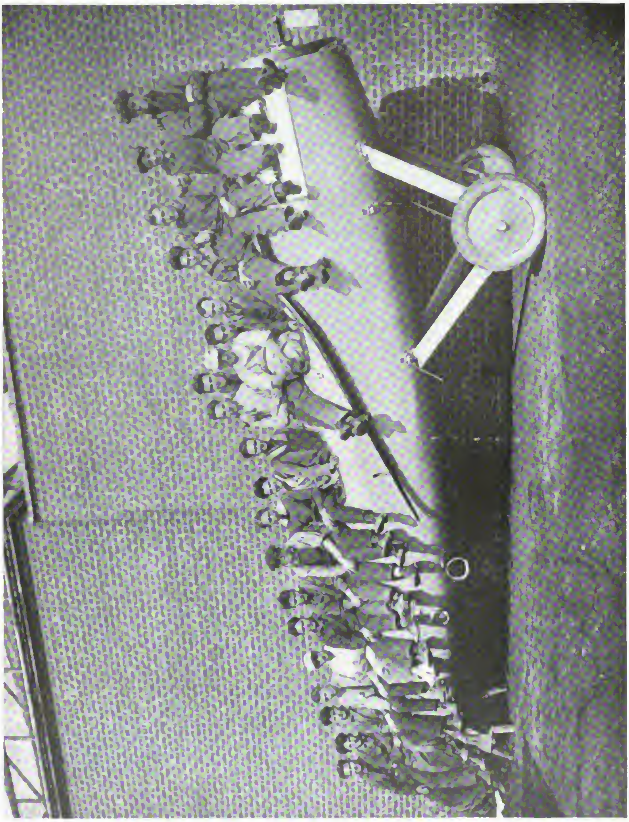

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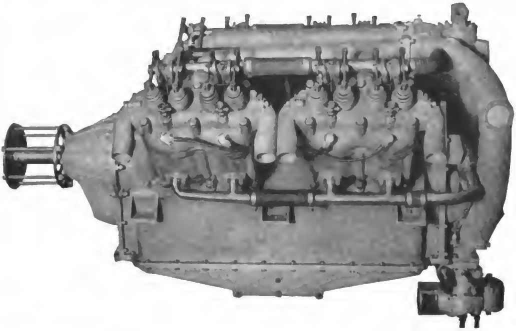

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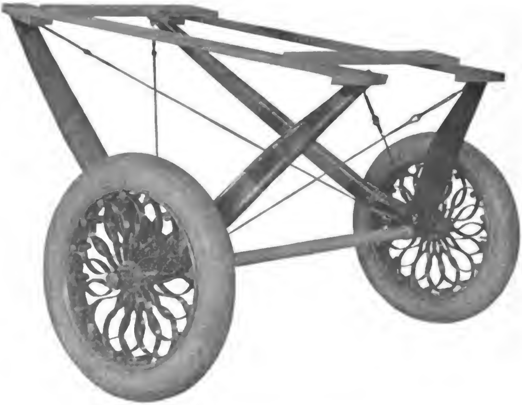

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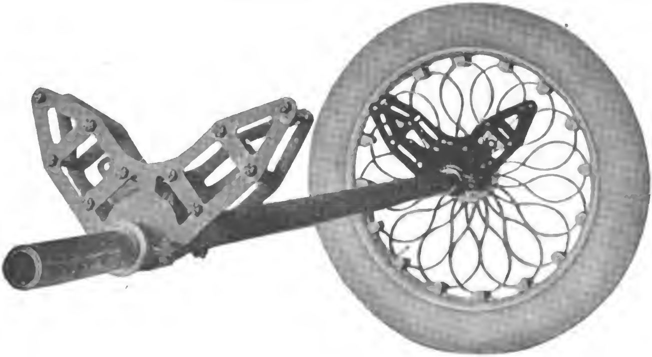

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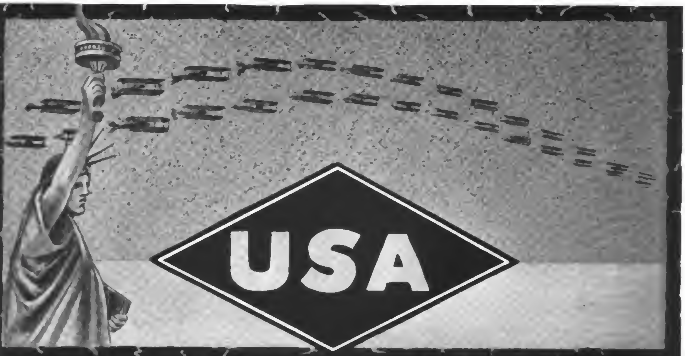

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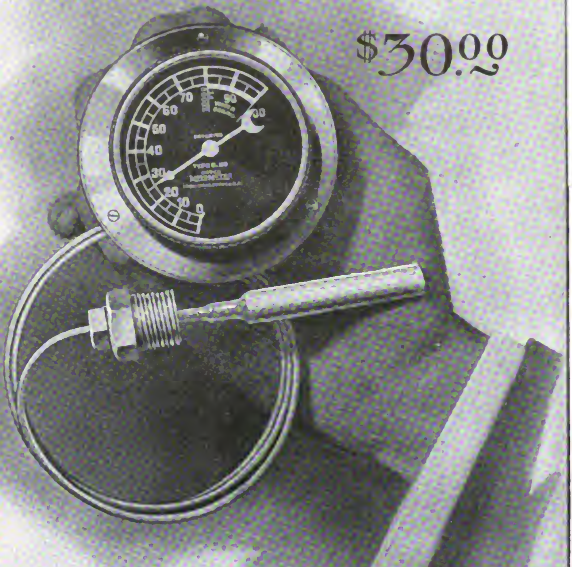

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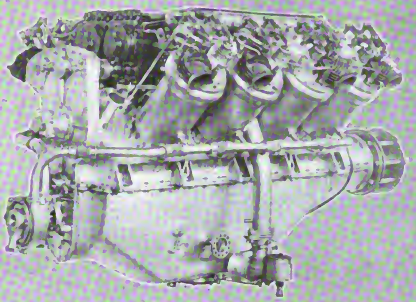

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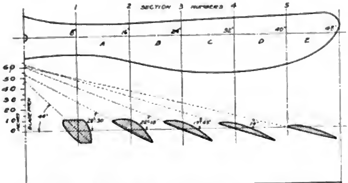
Vol. III December 1, 1917 No. 9

Airscrew Analysis

By A. F. Zahm

Introduction

Scope.—In a mathematical estimate of the merits of an airscrew it is customary to make, (1) an aerodynamic analysis; (2) a stress analysis; the first to determine the performance, the second the structural safety.



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REMARK.—SPECIFIC GRAVITY OF PROPELLER WOOD, 487; TENSILE STRENGTH 9000 POUNDS PER SQUARE INCH							

FIG 1.—PROPELLER BLADE DIMENSIONS

Basic Data for Airscrew Analysis.—Most airscrews consist of one or more blades secured to, or integral with, a central hub designed to be carried by a shaft rotating about an axis and moving along it. From hub to tip the blade varies in cross-sectional form, size and incidence. These three elements are usually planned to ensure the greatest efficiency consistent with structural safety and adequate thrust. Basic data for a typical airscrew are given in Figs. 1 and 2.

Aerodynamic Analysis

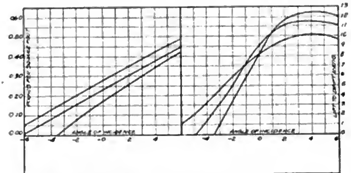
Velocity and Air Force at Any Blade Section.—Each point of an airscrew blade describes a helical path whose pitch is constant when the speeds of rotation and translation bear a fixed ratio. The path is usually referred not to fixed space but to the general mass of approaching air, since this itself may be in translation. Fig. 3 shows how to find graphically the helix angle A, the incidence i, and resultant velocity $\overline{V}$, at any point of a blade whose peripheral and forward velocities, referred to the general air mass, are given.* Analytically A, i, and $\overline{V}$ are computed by the formulas:

$$\tan A = V/2\pi rN \qquad (1)$$

$$\overline{V} = (V^2 + 4\pi^2r^2N^2)^{1/2} \qquad (2)$$

$$i = B - A$$

where V is the translational, N the rotational speed, r the radial distance of the moving point, and B the blade angle at r.



ANGLE OF ATTACK		-6°	-5°	-4°	-3°	-2°	-1°	-0°	1°	2°	3°	4°	5°	6°
LIFT POUNDS PER SQUARE FOOT	SECTION NUMBERS 1													
	2	0438		1011		1721		25		2025		3395		394
	3	—		40		1175		1895		249		305		359
	4-5	—		375		639		147		2108		2376		339
LIFT TO DRIFT RATIO	SECTION NUMBERS 1													
	2	009		29		61		82		96		102		97
	3	—		15		54		95		111		118		109
	4-5	—		—		27		60		116		128		12.1

FIG 2.—AERONAUTICAL DATA AND BLADE SECTIONS

The unit air force at any section with speed $\overline{V}$, may be found in magnitude very approximately by the formula

$$R = K\rho\overline{V}^2 \qquad (3)$$

in which ρ is the density, K is the air force per unit surface at unit speed for an aerofoil having the form and incidence of said section and moving in air of unit density.† The direction of R in terms of the incidence is commonly known from aerofoil experiments. Otherwise the unit lift and drift are computed, and thence the resultant force. The unit lift is $L\rho\overline{V}^2$; the drift is $D\rho\overline{V}^2$; their ratio, $D/L = \tan^{-1}G$, gives the "gliding angle," or direction of R referred to the lift.‡ If $\overline{V}$ be in miles per hour the lift and drift per square foot are $.0051L\overline{V}^2$, and $.0051D\overline{V}^2$, respectively.

Thrust and Torque, Thrust Power and Torque Power.—The forward component R_y of the air force in Fig. 3 is the unit thrust; the peripheral component R_x, multiplied by the section radius is the unit torque. Multiplying these units by the blade width gives the thrust and torque per unit length of blade, as tabulated and plotted in Fig. 4; and integrating obviously gives the whole thrust and whole torque for the blade. From these are derived the thrust power and torque power, on multi-

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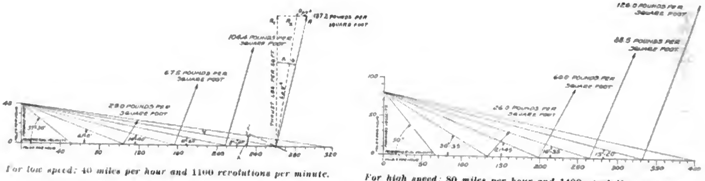
* It is here assumed that the air approaches the screw plane normally with uniform velocity V. A slight correction for this assumption must be made. No perfectly adequate formula is available for this correction. Riach proposes a theoretical formula assuming V normal to the screw plane and increasing in velocity.—Journ. Aeron. Soc. Gt. Brit., March 21, 1917.

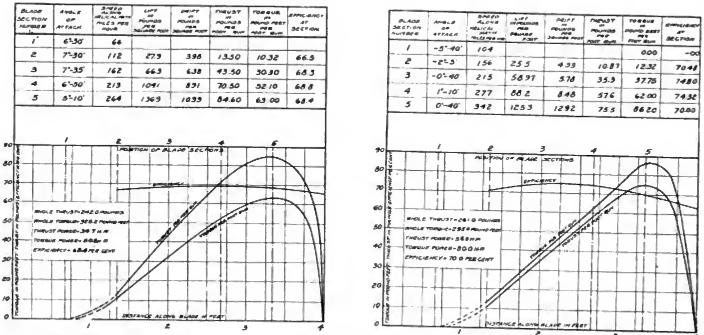
† The effect of air viscosity and compressibility are here ignored. No material error thereby ensues. See J. C. Hunsaker, Theory of Similitude of Aerial Propellers; also Edgar Buckingham, Physical Similarity.

‡ L and D are the absolute lift and drift coefficients, or the components of K taken respectively with and across the relative wind


137.2 POUNDS PER SQUARE FOOT
104.4 POUNDS PER SQUARE FOOT
67.5 POUNDS PER SQUARE FOOT
29.0 POUNDS PER SQUARE FOOT
THRUST LBS. PER SQ. FT.
48
0
40
80
120
160
200
240
280
320
126.0 POUNDS PER SQUARE FOOT
88.5 POUNDS PER SQUARE FOOT
60.0 POUNDS PER SQUARE FOOT
26.0 POUNDS PER SQUARE FOOT
100
50
0
50
100
150
200
250
300
350
400

For low speed: 40 miles per hour and 1100 revolutions per minute. *For high speed: 80 miles per hour and 1400 revolutions per minute.*

FIG. 3.—VELOCITY AT VARIOUS BLADE SECTIONS AND RESULTANT AIR FORCE PER SQUARE FOOT



BLADE SECTION NUMBER	ANGLE OF ATTACK	SPEED ALONG HELICAL PATH MILES PER HOUR	LIFT IN POUNDS PER SQUARE FOOT	DRIFT IN POUNDS PER SQUARE FOOT	THRUST IN POUNDS PER FOOT RUN	TORQUE IN POUND FEET PER FOOT RUN	EFFICIENCY AT SECTION
1	6°-30'	66					
2	7°-30'	112	27.9	398	13.50	10.32	66.5
3	7°-35'	162	66.3	638	43.50	30.30	68.3
4	6°-50'	213	1041	891	70.50	52.10	68.8
5	5°-10'	264	1369	1099	84.60	63.00	68.4

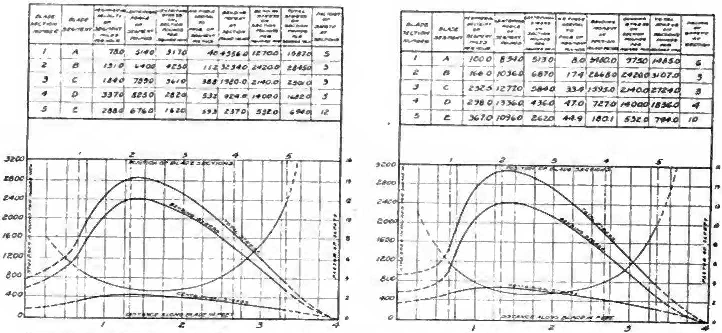
WHOLE THRUST=242.0 POUNDS
WHOLE TORQUE=328.2 POUND FEET
THRUST POWER=34.7 H.P.
TORQUE POWER=50.8 H.P.
EFFICIENCY=68.4 PER CENT

BLADE SECTION NUMBER	ANGLE OF ATTACK	SPEED ALONG HELICAL PATH MILES PER HOUR	LIFT IN POUNDS PER SQUARE FOOT	DRIFT IN POUNDS PER SQUARE FOOT	THRUST IN POUNDS PER FOOT RUN	TORQUE IN POUND FEET PER FOOT RUN	EFFICIENCY AT SECTION
1	-5°-40'	104				0.00	-00
2	-2°-5'	156	25.5	4.39	10.87	12.32	70.48
3	-0°-40	215	56.97	5.78	35.3	37.75	74.80
4	1°-10'	277	88.2	8.48	57.6	62.00	74.32
5	0°-40'	342	125.3	12.92	75.5	86.20	70.00

WHOLE THRUST=261.0 POUNDS
WHOLE TORQUE=295.4 POUND FEET
THRUST POWER=56.0 H.P.
TORQUE POWER=80.0 H.P.
EFFICIENCY=70.0 PER CENT

For low speed: 40 miles per hour and 1100 revolutions per minute. *For high speed: 80 miles per hour and 1400 revolutions per minute.*

FIG. 4.—THRUST, TORQUE AND POWER EFFICIENCY



BLADE SECTION NUMBER	BLADE SEGMENT	PERIPHERAL VELOCITY OF SEGMENT MILES PER HOUR	CENTRIFUGAL FORCE OF SEGMENT POUNDS	CENTRIFUGAL STRESS ON SECTION POUNDS PER SQUARE INCH	AIR FORCE NORMAL TO FACE OF SEGMENT POUNDS	BENDING MOMENT AT SECTION POUND-INCHES	BENDING STRESS ON SECTION POUNDS PER SQUARE INCH	TOTAL STRESS ON SECTION POUNDS PER SQUARE INCH	FACTOR OF SAFETY AT SECTION
1	A	78.0	514.0	317.0	4.0	4356.0	1270.0	1587.0	5
2	B	131.0	640.0	425.0	11.2	3234.0	2420.0	2845.0	3
3	C	184.0	789.0	361.0	38.8	1980.0	2140.0	2501.0	3
4	D	337.0	825.0	282.0	53.2	824.0	1400.0	1682.0	5
5	E	288.0	676.0	162.0	59.3	237.0	532.0	694.0	12

BLADE SECTION NUMBER	BLADE SEGMENT	PERIPHERAL VELOCITY OF SEGMENT MILES PER HOUR	CENTRIFUGAL FORCE OF SEGMENT POUNDS	CENTRIFUGAL STRESS ON SECTION POUNDS PER SQUARE INCH	AIR FORCE NORMAL TO FACE OF SEGMENT POUNDS	BENDING MOMENT AT SECTION POUND-INCHES	BENDING STRESS ON SECTION POUNDS PER SQUARE INCH	TOTAL STRESS ON SECTION POUNDS PER SQUARE INCH	FACTOR OF SAFETY AT SECTION
1	A	100.0	834.0	513.0	8.0	3460.0	975.0	1485.0	6
2	B	166.0	1036.0	687.0	17.4	2668.0	2420.0	3107.0	3
3	C	232.5	1272.0	584.0	33.4	1595.0	2140.0	2724.0	3
4	D	298.0	1336.0	436.0	47.0	727.0	1400.0	1836.0	4
5	E	367.0	1096.0	262.0	44.9	180.1	532.0	794.0	10

For low speed: 40 miles per hour and 1100 revolutions per minute. *For high speed: 80 miles per hour and 1400 revolutions per minute*

FIG. 5.—STRESSES AND FACTOR OF SAFETY

plying respectively by the forward and the rotational speed.*

For use with a propeller computer, to be described presently, the unit thrust is written

$$R_y = .0051\overline{V}.L.V\sec G\cos(A+G) \ldots\ldots\ldots (4)$$

when $.0051\overline{V}$ is called the "velocity factor"; $\overline{V}\sec G\cos(A+G)$ the "thrust factor." Fig. 3 shows that this thrust factor times the lift on an element equals the unit thrust there.

Efficiency.—The efficiency of a propeller, or any part thereof, is the ratio of the useful to the total work in propulsion; or the ratio of the thrust power to the torque power either for the whole or for the part in question.

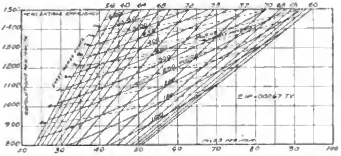


FIG. 6.—PROPELLER THRUST, POWER AND EFFICIENCY FOR VARIOUS SPEEDS

By a well known formula the efficiency of an elementary segment of the blade contained between two cylinders coaxial with the screw is

$$\epsilon = \tan A / \tan (A + G) \ldots\ldots\ldots\ldots\ldots (5)$$

For proof, Fig. 3 shows that $\overline{V}_y/\overline{V}_x = \tan A : R_y/R_x = 1/\tan(A+G)$

Their product is the efficiency. These statements are true of all blades whatever the form of flow past them, providing $\tan G$, = drift/lift, represent the actual flow. A curve of section efficiency ϵ, derived from this formula is plotted in Fig. 4, together with the corresponding thrust t, and torque q, per foot run.

In practice the curve of running torque q, is derived from the other two by the formula

$$q = ct/\epsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

where c is the ratio V/ω, of the speeds of translation and rotation (in radians per second). From these efficiency and torque curves the efficiency for the entire blade may be found by piecemeal integration.† But the aggregate efficiency is more simply found as the ratio of the whole thrust power to the whole torque power, once these have been computed.

Map of Propeller Characteristics.—When a propeller becomes of permanent interest, a map giving two of its chief characteristics, e.g., its aggregate thrust and efficiency, is made, as in Fig. 6, from which the other three, i.e., the thrust-power, torque and torque power, are readily derived. The map not only tells at a glance the capabilities of the given propeller, but also, through well known laws of comparison, to be given presently, serves to compute quickly the output of others similar to it. The making of this map, which involves several repetitions of the computations already explained for a succession of speeds, is laborious by the usual method, as here indicated, but easy and brief by the use of a suitable instrument.

Propeller Computer.—Fig. 7 shows a kind of slide rule by which the thrust, efficiency, etc.—also various incidental properties of a propeller blade—can be quickly derived. A transparent sliding radial arm, having a central "velocity line" graduated to a linear velocity scale, is pivoted at one corner of a cross-section sheet whose ordinates and abscissae are respectively the forward and peripheral speeds of the blade at various radial distances.

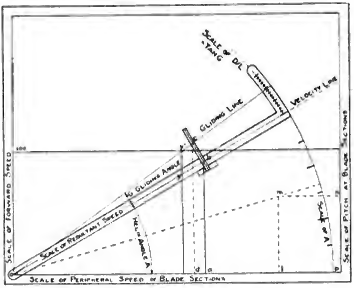


FIG. 7.—PROPELLER COMPUTER

Since $oa = 2\pi rN$, $ab = v$, .:. $ob = V = (4\pi^2 r^2 N^2 \times v^2)$ ½, called "path velocity."
Since section efficiency $e = \tan A / \tan (A \times G = y / y'$, .:. $e = y$, if y' be chosen = 100.
Since $od = oc \times \cos (A + G)$, and $oc = V \sec G$, .:. $od = V \sec G \cos (A + G)$, called "thrust factor."
If ol = radius of any blade section whole blade angle = mol, then $pn = 2\pi ml$ = pitch at section.
Path velocity ob, section efficiency y, thrust factor od, pitch pn, all read directly; also helix angle A.

If the radial slide is set with its velocity line passing through the "velocity point" b, on the paper, i.e., a point whose coordinates are the component speeds of any blade section, then ob on this line represents that section's helical velocity V, while its inclination to the X-axis is the helix angle A for the path of each point of that section, and is read in degrees on the graduated arc at the margin of the paper. This angle taken from the known blade angle for the section gives the incidence.

The center line of the radial arm is also graduated to read $.0051V$, called the "velocity factor" in equation (4), and used to find the thrust when V is in miles per hour.

Now setting the shown "gliding line," or thread, upon the $\tan G$ scale at the number expressing the drift/lift ratio for this incidence, its inclination to the X-axis is the angle $A + G$. Then is read at once the section efficiency ϵ, as the ratio

	a				b			c	d	
Section Radius Feet	Chord Length Feet	Blade Angle	Blade Incidence	Blade Curve Number	Lift Coeff.	Drift / Lift	Section Efficiency	Velocity Factor .0051V	Thrust Factor	Thrust per Foot Run
Given	Given	Given	Found by Subtraction	Given	Given	Given	Read on Instrument	Read on Instrument	Read on Instrument	Product of a, b, c, d.

FIG. 8.—EFFICIENCY AND RUNNING THRUST AT VARIOUS BLADE SECTIONS

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* The method of this paragraph is usually attributed to S. Drzewiecki: see his Des Hélices Aériennes, Paris, F. Louis Vivien, 1909.

† If q, ϵ, be the running torque and efficiency at the radial distance r along the blade, the efficiency for the whole blade is $E = \Sigma q\epsilon dr / \Sigma q dr$

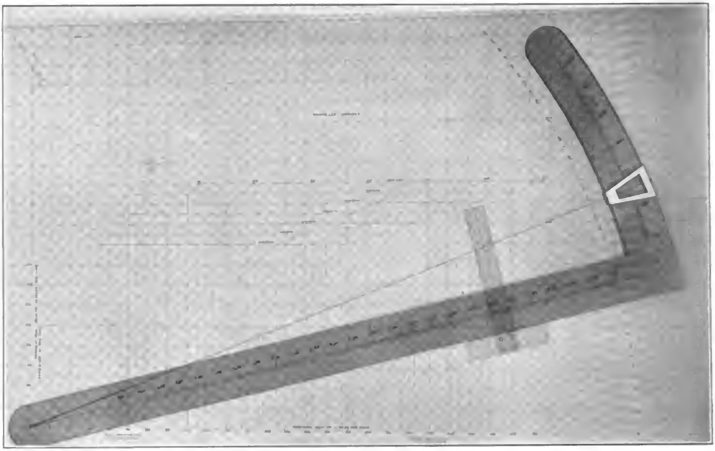


FIG. 9.—PROPELLER COMPUTER

$\tan A/\tan(A + G)$, or the ratio y/y^1 of any two coincident ordinates y, y^1, reaching up respectively to the velocity line and the thread or gliding line. If y^1 be chosen as 100, y is the exact percentage efficiency.

Next the black center line of a transparent T-square is laid over the velocity point *b*, and squarely across the radial arm, and across the gliding line at the "thrust point" *c*, whose abscissa is the "thrust factor," $V\sec G\cos(A + G)$.

All the numerical value thus far read from the instrument, together with some given properties and dimensions of the blade sections, are entered in a row, as in Fig. 8. Under them are inserted like readings for other blade sections. Columns *a*, *b*, *c*, and *d*, are now multiplied together giving the last column. The entire work of taking and entering the readings occupies less than ten minutes.

A practical form of the instrument, as exhibited in Fig. 9, comprises: (1) a sheet of ordinary section paper on a drawing board; (2) a transparent celluloid ruler with one end pivoted at the origin, the other curved to a circular arc; (3) a small celluloid T-square to slide along the straight length of the ruler. Riding on the ruler is a fine thread reaching from the pivot to an aluminum slide which plays freely along the arc. A fuller treatment of the theory and operation of this instrument is given by W. P. Loo in the *Journal of the Franklin Institute* for December, 1917.

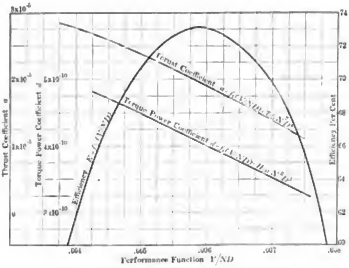


FIG. 10.—MAP OF PROPELLER COEFFICIENTS

Laws of Comparison.—The air force on a small element of a propeller may be written:

$$R = \rho A\overrightarrow{V}^2f(i)$$

in which A is the element's area, i its incidence. For an airscrew of fixed shape having a forward velocity V, if i remains constant while the diameter D, and angular speed N, vary,

$$R = \rho N^2D^4f(V/ND)$$

since $A \propto D^2$, $V \propto ND$, and i is a function of V/ND. Since the axial and peripheral components of R are similarly expressed, their summation, or the whole thrust and torque may be written

$$\text{Thrust, } T = \rho N^2D^4f_1(V/ND) \qquad (7)$$
$$\text{Torque, } Q = \rho N^2D^5f_2(V/ND) \qquad (8)$$

From these follow at once

$$\text{Thrust power} = TV = \rho N^3D^5f_3(V/ND) \qquad (9)$$
$$\text{Torque power} = 2\pi QN = \rho N^3D^5f_4(V/ND) \qquad (10)$$
$$\text{Efficiency} = TV/2\pi QN = f_5(V/ND) \qquad (11)$$

These five equations furnish useful laws of comparison between geometrically similar propellers. For example if two such screws move at any chosen V/ND in media whose densities are respectively ρ and ρ_1, their thrusts are thus related:

$$T/T_1 = \rho N^2D^4/\rho_1N^2_1D^4_1$$
$$\therefore T = a_1\rho N^2D^4,$$
$$\text{where } a_1 = T_1/\rho_1N^2_1D^4_1 = f_1(V/ND)$$

If therefore a_1 be observed, or given, for one screw of diameter D_1, the thrust T, of any other, of diameter D, moving with the same V/ND, is found by simple multiplication. Similarly for the torque, etc. Thus it appears that the propeller map here treated furnishes directly the characteristics of a particular airscrew, and, by comparison, those of geometrically similar screws.

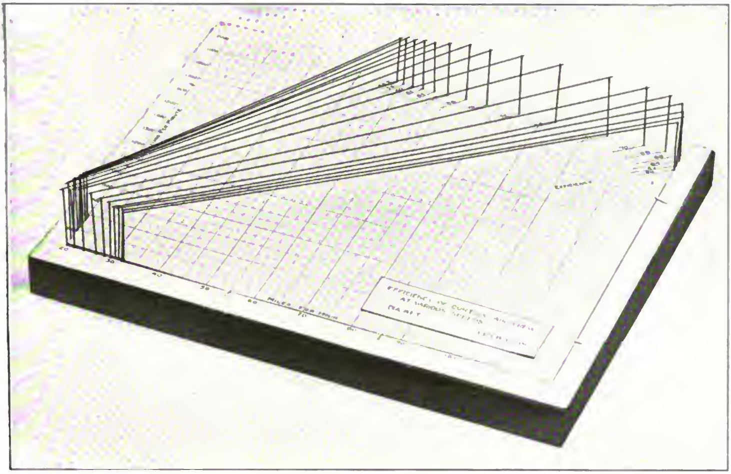


Fig. 11.—Efficiency Surface

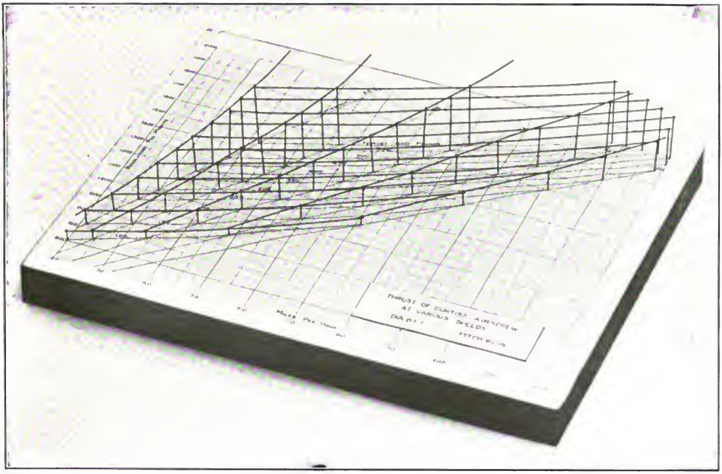
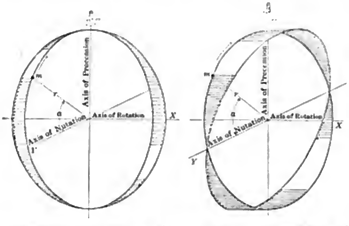


Fig 12.—Thrust Surface

Map of Propeller Coefficients.—Assuming V/ND constant, equations 7, 8, 9, 10 and 11, may be written

$$\text{Thrust} = a\rho N^2D^4 \ldots\ldots (7')$$
$$\text{Torque} = b\rho N^2D^5 \ldots\ldots (8')$$
$$\text{Thrust power} = c\rho N^3D^5 \ldots\ldots (9')$$
$$\text{Torque power} = d\rho N^3D^5 \ldots\ldots (10')$$
$$\text{Efficiency} = E = \text{const} \ldots\ldots (11')$$

in which a, b, c and d are constants for the given value of V/ND, and are called respectively "thrust coefficient," "torque coefficient," etc. Since as above seen each of these four coefficients is a function of V/ND, it is common practice to plot two of them against V/ND, as in Fig. 10. The corresponding propeller characteristic is then found for any value of V/ND, by taking the appropriate coefficient from the diagram and substituting in the proper equation above. For example if $a = \rho f_1(V/ND)$, and $d = \rho f_4(V/ND)$, be taken from the diagram and substituted in (7') and (10') respectively, they give the thrust and the torque power. From these two characteristics the other three follow as already explained.



Perspective representation of gyroscopic velocity of a particle, m.

Perspective representation of gyroscopic acceleration of a particle, m.

FIG. 13.—VELOCITY AND ACCELERATION OF GYROSCOPIC PARTICLE

Comparison of Maps.—Thus from a map of propeller coefficients one finds by computation values which can be read directly from a map of propeller characteristics. The latter map is more expensive when seldom used; more economical when frequently used for hurried reference. Given either map the other can be produced from it through equations[*] 7', 8', 9', 10'.

Relief Map of Propeller Characteristics.—The efficiency and thrust values given in Fig. 6 are plotted in relief in Figs. 11 and 12, respectively. The efficiency surface—a species of cylindroid—has for equation $E = f_3(V/N)$, and is generated by a right line rotating about the Z-axis, while oscillating along and perpendicular to it.[†] The thrust surface has for equation $T = N^2f_1(V/N)$, and is generated by a parabola coaxial with Z and roating about it with varying parameter. Similarly for the torque surface $Q = N^2f_2(V/N)$. The power surfaces are obviously generated by cubic parabolas rotating about Z with altering parameters. Viewed otherwise, the plane V/N = constant contains those generators of the characteristic surfaces and carries them with it while rotating about Z with varying parameter; the parabolas expanding and contracting; the straight line sliding to and fro along Z; and all their projections coinciding with the efficiency line, or trace of the rotating plane on the reference plane V N.

If the form of any two of these functions, say $f_1(V/N)$, $f_2(V/N)$, were known, the equations to all the five surfaces could be written at once, thus furnishing complete mathematical expressions for the five propeller characteristics. Such functions can be derived analytically when adequate formulae in terms of V and N, are found for L and D, and the velocity and incidence of the air flow at each section of the propeller blade.

The efficiency lines in Fig. 6 are obviously projections of the intersections of the efficiency surface made by planes normal to Z and cutting it at distances from the origin equal to 56, 58, 60, etc., up to 73. Similarly the thrust lines are projections of intersections of the thrust surface made by planes normal to Z and cutting it at distances 100, 150, etc. Similarly for the power curves.

Stress Analysis

Scope.—The stresses in an aircrew may be due (*a*) to constant velocities of rotation and translation, or (*b*) to variations in one or both.

In *steady rectilinear flight* an airscrew with straight blades—the only form here treated—is subject to two kinds of loading: (1) centrifugal, which begets in the blades purely tensile stress; (2) aerodynamic, which begets bending stress.

To these must be added for *unsteady flight* inertia loads due to three kinds of change of motion: (1) translatory acceleration; (2) rotatory acceleration; (3) precession or nutation. The aerodynamic effects of such velocity changes are slight and not treated here.

(*a*) *Stresses in Steady Flight.*—For steady rectilinear flight we may first find the centrifugal, then the bending stress, then by superposition find their resultant.

Centrifugal Stress.—The centrifugal force F, at any cross-section of a blade is found by the formula $F = Mv^2/r$, v being the peripheral speed, r the distance, of the center of mass M of the blade segment tending to fly outward from the section in question. Usually this outward segment is mentally cut into smaller segments, whose mass and peripheral speed are first computed then substituted in the given formula, $F = \Sigma mv^2/r$. Dividing F by the section area now gives the average centrifugal stress.

Bending Stresses.—The bending moment M, at any section of a straight radial blade is computed by the formula $M = \Sigma fl$, where f, taken normal to the plane of the neutral surface at the section, is the component of the air force on any small block of the outer segment of the blade, l its distance from the section. Dividing M by the section modulus gives the bending stress in the outer fiber at the section.

Resultant Stress and Safety Factor.—The bending stress is plus or minus; the centrifugal is plus; the maximum is the greatest sum of the positive or tensile stresses. Dividing this sum into the tensile strength of the material gives the factor of safety.

Diagram of Stresses and of Safety Factor.—Fig. 5 portrays graphically the foregoing stresses and factor of safety for all parts of a blade except the tip where they die away, and the root where they are negligible if the hub be properly designed.

Grouping of Data and Analytic Results.—Figs. 1 to 6 present in systematic order the data and analytic results for an entire aerodynamic and stress analysis of a propeller at both high and low speeds of steady flight. The basic data are given in Figs. 1 and 2; the analytic results are given for low speed and for high speed in Figs. 3, 4 and 5. The propeller map, showing the thrust, power and efficiency at various speeds, is reproduced in Fig. 6, and is the aggregate result of a complete aerodynamic analysis for a graded set of speeds of translation and rotation.

(*b*) *Load Increments Due to Unsteadiness of Flight.*—The added stresses due to unsteadiness of flight are usually smaller than those just treated, but require passing notice.

Translatory Acceleration Loads.—If the screw receives a translatory acceleration j, every particle m opposes this with a force mj, which in practice is negligibly small.

Rotatory Acceleration Loads.—If the screw receives an acceleration α about its axis, every particle m opposes this with an inertia force $m\,r\,\alpha$, or an axial torque $m\,r^2\,\alpha$, where r is the radial distance of m. Hence the axial torque offered by any blade segment against rotatory acceleration is

$$Q = \Sigma m\,r^2\,\alpha \ldots\ldots (12)$$

integrated throughout the segment, and from this value the moment at any blade section, due to the mass of said segment, can be found by elementary statics.

The inertia torque for the whole blade, that is

$$Q = \Sigma\,(m\,r^2\,\alpha)\,\overset{R}{\underset{0}{}} = I\,\alpha \ldots\ldots (13)$$

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[*] From these equations it is seen that for ρ, D, V/ND, constant the thrust and torque vary as N^2, the thrust power and torque power vary as N^3, and the efficiency is a constant function of V/N. Hence if these five characteristics be known for one ratio of V/N they are determinate for all values of V, N, having that ratio. Thus all the curves of thrust shown in Fig. 6 are derived from a single one by the relation $T \propto N^2$. Similarly for the curves of torque, thrust power and torque power. The efficiency graphs are obviously all straight lines through the origin of V and N.

[†] The Z-axis is here assumed normal to the paper and co-ordinate with the V and N axes.

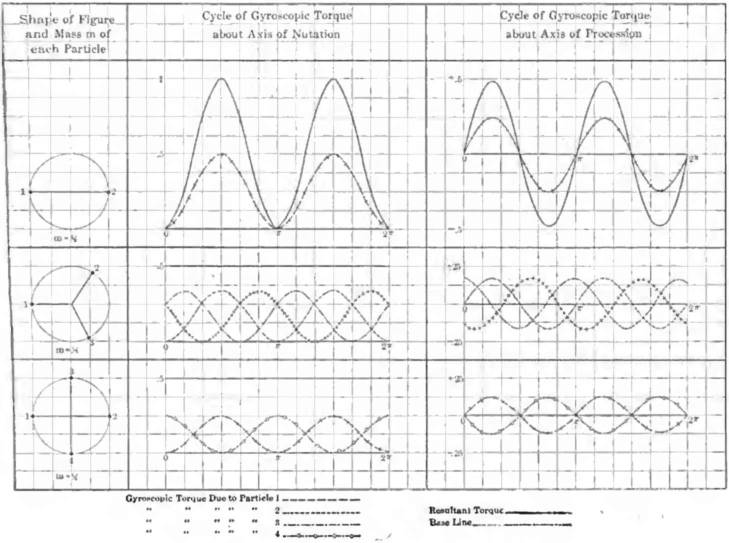
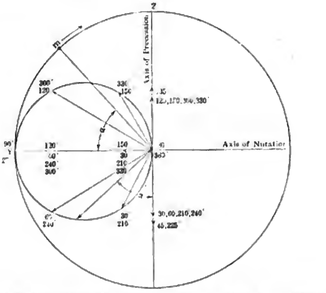


Fig. 14.—Gyroscopic Torque for Symmetric Particle Groups



Axis of Rotation Perpendicular to Plane of Paper with Positive Direction Upward. Component Torques Represented by Arrows on the Axes. Resultant Torques Represented by the Oblique Arrows.

Fig. 15.—Vector Torque Diagram for a Gyroscopic Particle

where I is the axial moment of inertia, equals the engine torque less the air resistance to rotation. If the screw runs at full speed, first at no throttle, then at full throttle, the opposing blade torque changes from a small negative to full positive value.

*Gyroscopic Loads.**—To express the gyroscopic resistance to pitching and yawing, assume fixed centroidal axes X, Y and Z, through the airscrew parallel to the conventional axes of the airplane, X being the longitudinal axis of the latter; and let ω and Ω, be the angular speeds of rotation and of yaw without pitching. Then any particle m at xyz has parallel to X the linear speed $y\ \Omega$, and the linear acceleration $z\ \omega\ \Omega$, as shown graphically in Fig. 13. Multiplying this acceleration by m gives the force

$$f = mz\omega\Omega \qquad (14)$$

which varies at quadrant intervals through the values o, m, $r\ \omega\ \Omega$, o, and $-m\ r\ \omega\ \Omega$. This force exerts about Y and Z respectively the torques

$$q_Y = mz^2\omega\Omega \qquad (15)$$
$$q_z = -myz\omega\Omega \qquad (16)$$

which also vary cyclically, as illustrated in Fig. 14, and, together with their resultant, in Fig. 15. Similar effects ensue from pitching without yaw.

The above expressions and the figures illustrating them, show that for yaw without pitch the gyroscopic force on m is always parallel to X, and reverses twice each revolution; that its torque about Y is always positive and fluctuates from zero to a maximum, $m\ r^2\ \omega\ \ \Omega$, twice each revolution; that its torque about Z oscillates from $m\ r^2\ \omega\ \ \Omega/2$ to $-\ m\ r\ \omega\ \ \Omega/2$ twice each revolution; that the resultant torque is a maximum, $m\ r^2\ \omega\ \ \Omega$, when the particle is crossing the XZ plane. Similar conclusions are obvious for pitch without yaw.

The entire gyroscopic force on any blade segment is parallel to X, and, when at its maximum value, is very closely

$$F = \Sigma m r\omega\Omega\dagger = M\bar{r}\omega\Omega \qquad (17)$$

in which M is the mass of the segment, $\bar{r}$ the radial distance of its centroid. This force is at a distance $r_1 = r_g^2/\bar{r}$ from X,

---

* For a fuller treatment see the writer's "Periodic Stresses in Gyroscopic Bodies with Application to Airscrews," Report of National Advisory Committee for Aeronautics, 1917.

† Owing to the width and thickness of the blade this expression is in slight error—less than one part in 5000 for ordinary blades.

where r_2 is the radius of inertia of the segment referred to X.

The maximum gyroscopic torque about Y for yawing without pitch is, for any blade segment, $\Sigma\, m\, z^2\, \omega\, \Omega$, integrated throughout the segment; and for a whole screw is

$$Q = I\,\omega\Omega \qquad (18)$$

in which I is the moment of inertia referred to X of the entire screw. The gyroscopic torque of the whole screw or any segment is found for any position α, Fig. 13, by multiplying the maximum by $\sin^2 \alpha$.

Since the entire gyroscopic force on a blade fluctuates like that of a particle, the moment about Y ranges from zero to $I\,\omega\,\Omega$, about Z from $I\,\omega\,\Omega/2$ to $-I\,\omega\,\Omega/2$, twice each revolution. The equivalent gyroscopic stress may therefore be computed as for a repetitive load ranging many times per second from zero to $I\,\omega\,\Omega$.

The 450 Horsepower Friedrichshafen Bomber*

By Jean Lagorgette

The Friedrichshafen Aircraft Works (Flugzeugbau Friedrichshafen, Gesellschaft m.b.H.), which has long specialized in the construction of seaplanes equipped with one and two engines, is now manufacturing a twin-engined bombing airplane, several samples of which have recently been captured on the French front near Verdun and in Macedonia.

This new German bomber possesses substantially the same features as that produced by the Gotha Wagon Works, and might, in fact, be termed a small Gotha. On the other hand, the Friedrichshafen bomber has a great resemblance to the twin-engined seaplane of the same concern, the chief difference consisting in the sweepback of the wings, which is a reversion to earlier German practice.

The Friedrichshafen bomber has an upper span of 20.30 m. and a lower span of 18.85 m., giving an overhang of only 0.72 m. at the wing tips. The wings are slightly tapering in width from the body toward the tips, the chord measuring, respectively, 2.30 m. and 1.80 m. The interplane gap is 1.95 near the body and increases slightly at the tips. The surface area of the wings is 70 sq. m. The overall length of the machine is 11 m.; the overall height, measured from the ground to the upper edge of the rudder, is 4.10 m.

The wings have a slight transverse dihedral, except at the center section, which is rectilinear, and embody a slight backsweep and decalage, the upper plane being offset forward. The trailing edge of the planes is deeply cut out in order to afford clearance to the airscrews.

The wing spars consist of steel tubes in the center section, beyond which they are built up of laminated wood. In accordance with current German practice, the front spar is located very close to the leading edge, at about 0.40 m. from the latter, while the rear spar is situated rather far from the trailing edge, the spars being spaced at about 1 m. from one another. Contrary to what is found in the Gotha, the wing ribs are parallel to the longitudinal axis of the machine.

On the outer side of each engine the wings are braced by two pairs of interplane struts, which are inclined outward; the inner pairs are slightly more inclined than the outer pairs, thus giving the top plane a sharper transverse V than to the lower plane. The overhang of the top plane is, furthermore, braced by stay wires to the lower base of the outer struts.

The wings are painted green and brownish red on the upper surface, and light blue on the lower surface.

The ailerons have an irregular shape and are balanced at the wing tips; they are built up of steel tubing. The surface area of each aileron is 2.30 sq. m.

The elevator has an overall span of 3.95 m. and is 3.65 m. long. The rudder is 1.93 m. high and 0.90 m. wide. Both the elevator and the rudder are built up of steel tubing and are balanced. The fixed tail planes comprise a triangular, vertical fin and a heart-shaped empennage.

Unlike on the Gotha, where the body is a monocoque, the body of the Friedrichshafen bomber is of the well-known four-spar type, with wooden cross members, all suitably stayed. The forward portion, up to the engines, is covered with veneer, the remainder with canvas. The body has an overall height of 1.27 m. and a maximum width of 1.20 m. It can be taken apart at a point flush with the trailing edge of the wings, keys being employed to assemble the two parts. The center section of the planes is fixed to the body by means of a cabane consisting of four vertical steel struts.

In the forward end of the body seats are fitted in tandem fashion for the gunner and the pilot, the former occupying the front seat. The main fuel tank is mounted behind the pilot's seat, and bomb gears are arranged on either side of it. Astern of this is the seat for the second gunner. A passageway runs through the body from the forward to the after seat, thus enabling the crew to change places as the need may occur.

The undercarriage differs considerably from German practice as exemplified in one-engined machines, where it bears only against the body, or in twin-engined machines, where it bears on the wing panels. In the Friedrichshafen bomber the undercarriage bears, through the agency of suitable compression members, on the body as well as on the wing panels. The undercarriage consists essentially of two pairs of vertical struts, each pair bearing on the basis of each engine bed, and carrying twin-wheels on a common axle. Rubber strand shock-absorbers are used. The vertical struts are braced by tubular compression members to the body. No brake is provided on the undercarriage.

The tail skid is pivoted on a vertical post of steel tubing which is braced to the interior of the body. The lower portion of the skid is steel-shod.

The power plant is composed of two water-cooled, 6 cylinder Benz engines, developing from 221 to 226 hp. They are offset 2.10m. from the centerline of the machine, and are mounted each on four V-shaped struts, the apex of which bears, as has been said before, on the vertical struts of the undercarriage. The engines are surrounded by a streamlined bonnet, which mounts in front the radiator and tapers in the rear to a conical cap which is mounted on the airscrews. The diameter of the airscrews is 2.90 m. The fuel tanks are situated in the body, behind the pilot, and have a total capacity of 550 liters. The oil tanks are mounted underneath the radiators.

The control is of the Dep type.

The armament consists of three Parabellum machine guns. One each is mounted on the forward and after seats, en barbette, on a gun ring upon which the gun carriage is made to slide by a lever. The latter permits the locking of the gun in a given position. The third gun is mounted on the floor of the body, on a pivot, and can be fired by the after gun layer through a trap-door which may be operated by a lever. There is consequently no gun tunnel on this machine, like the one that was a conspicuous feature of the Gotha.

The central bomb gears are of the Gotha type. Six bombs are carried in a vertical row in a self feeding magazine; when one bomb is released another slides automatically into its place. Additional bombs may be carried amidwings, underneath the body, in a spring jaw suspension.

The gross weight of the machine is 2,200 kg., the fuel load, 520 kg., and the useful load (crew and ammunition) 432 kg. The total flight weight is, therefore, 3,152 kg., which gives a lift loading of about 45 kg. per sq. in. and a power loading of 7 kg. per horsepower.

Testing Airplane Fabrics

Extensive tests are being made at mills at New Bedford, Mass., to determine the best fabrics for use in airplane wings. Four representatives of the Department of Agriculture have been studying the various raw materials and the manufacture of goods with the object of perfecting an airplane fabric that will be superior to those now in use. The investigators are: William S. Dean, George S. Anderson, C. E. Coburn and R. V. Hellams.

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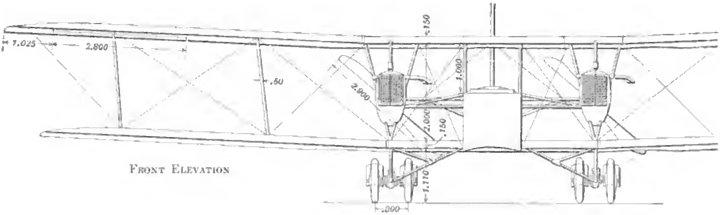
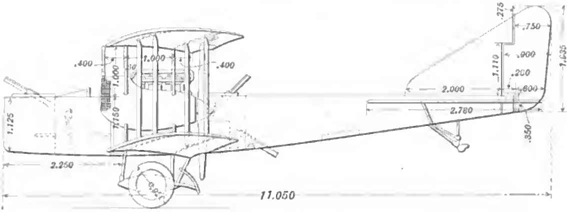
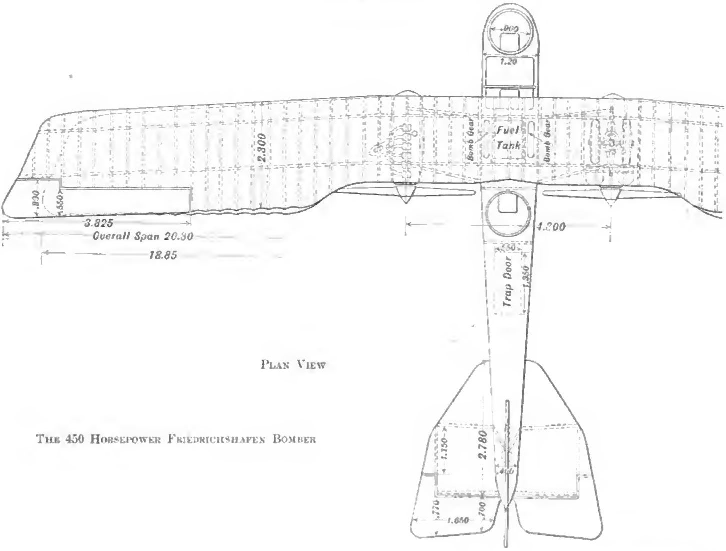
* Excerpt from *L'Aérophile.*



Front Elevation



Side Elevation



Plan View

The 450 Horsepower Friedrichshafen Bomber

The 160 HP. Benz and Mercédès Aircraft Engines Compared*

The 160 hp. Benz and the 160 hp. Mercédès engines are, at the present moment, thoroughly representative of current German practice in aircraft engine design, which is emphasized by the fact that nearly all of the enemy airplanes that have been captured by the Allies were found to be equipped with either Benz or Mercédès engines. A detailed analysis and dimensioned comparison of these two engines, which has been authorized by the British naval and military authorities, is, therefore, of timely interest.

Taken as a whole, the Benz and the Mercédès have many

TABLE 1.

General Detail.

		160 hp. Benz.	160 hp. Mercédès.
Number and arrangement of cylinders		Six, vertical	Six, vertical
Bore	In.	5.12	5.51
Bore	mm.	130.0	140.0
Stroke	In.	7.09	6.30
Stroke	mm.	180.0	160.0
Stroke/bore ratio		1.385 : 1	1.144 : 1
Area of one piston	Sq. in.	20.60	23.84
Total piston area of engine	Sq. in.	123.60	143.04
Swept volume of one cylinder	Cu. in.	146.05	150.20
Total swept volume of engine	Cu. in.	876.30	901.20
Volume of clearance space	Cu. in.	41.65	42.95
Compression ratio. Total volume/clearance volume		4.50 : 1	4.50 : 1
Normal B.H.P.	B.H.P.	160	162.5
Normal speed	R.P.M.	1400	1400
Piston speed	Ft. per min.	1655	1470
Brake mean pressure	Lb. sq. in.	103.00	102.00
Mechanical efficiency (calculated)	Per cent.	87.50	87.90
Indicated mean pressure (calculated)	Lb. sq. in.	117.7	116.0
Fuel consumption per B.H.P. hour (s.g. 0.730)	Lb.	0.520	0.522
Brake thermal efficiency (18,600 B.T.U.'s/lb.)	Per cent.	26.32	26.20
Indicated thermal efficiency	Per cent.	30.10	29.80
Air standard efficiency	Per cent.	45.20	45.20
Relative efficiency	Per cent.	66.60	65.95
Cu. in. of swept volume per B.H.P.	Cu. in.	5.48	5.54
Sq. in. of piston area per B.H.P.	Sq. in.	0.773	0.881
H.P. per cu. ft. of stroke volume	HP.	315.5	312.0
H.P. per sq. ft. of piston area	HP.	186.4	163.5
Direction of rotation of crank and propeller		Anticlock	Anticlock
Normal speed of propeller	R.P.M.	1400	1400
Oil consumption per hour (specific gravity, 0.900)	Lb.	4.93	5.69
Oil consumption per B.H.P. hour	Lb.	0.031	0.035
Number of carbureters	No.	Two	Two
Type of carbureters	Type	Benz	Mercédès
Fuel consumption per hour (specific gravity, 0.730)	Lb.	83.2	84.80
Number and type of magnetos		Two ZH6 Bosch	Two ZU6 Bosch
Firing sequence of engine		1, 5, 3, 6, 2, 4	1, 5, 3, 6, 2, 4
Ignition timing (degrees early, full advance)	Degrees	32	30
Inlet valve opens	Degrees	Top dead center	2 degrees late
Inlet valve closes	Degrees	60 degrees late	35 degrees late
Exhaust valve opens	Degrees	60 degrees early	63 degrees early
Exhaust valve closes	Degrees	18 degrees late	13 degrees late

TABLE Ia.

Calculated Friction Losses. (Lb. per sq. in. of piston area.)

		160 hp. Benz.	160 hp. Mercédès
Bearings, valve gear and auxiliaries	Lb. sq. in.	2.00	2.00
Fluid Pumping loss	Lb. sq. in.	4.50	4.00
Piston friction	Lb. sq. in.	8.20	8.00
Total Losses	Lb. sq. in.	14.70	14.00
Brake mean pressure	Lb. sq. in.	103.00	102.00
Calculated indicated mean pressure	Lb. sq. in.	117.70	116.00
Calculated mechanical efficiency	Per cent.	87.50	87.90

TABLE II.

Gas Velocities, Valve Areas, Etc.

	160 hp. Benz.	160 hp. Mercédès.
Gas Velocity (feet per second)—		
Vertical induction pipe	192.0	—
Induction manifold (or branch pipes)	192.0	164.7
Inlet port	123.6	104.5
Inlet valve	172.8	157.7
Exhaust valve	172.8	157.7
Exhaust port	123.6	104.5
Exhaust branch pipe	192.0	164.7
Cross Sectional Area (Sq. in.)—		
Vertical induction pipe	2.980	—
Induction manifold (or branch pipes)	2.980	3.546
Inlet port	4.600	5.600
Inlet valve (πdh.)	3.290	3.700
Exhaust valve (πdh.)	3.290	3.700
Exhaust port	4.600	5.600
Exhaust branch pipe	2.980	3.546
Diameter (In.)—		
Vertical induction pipe	1.950	—
Induction manifold (or branch pipes)	1.950	2.125
Inlet port	2.420	2.677
Exhaust port	2.420	2.677
Exhaust branch pipes	1.950	2.125

TABLE III.

Inertia Forces, Bearing Loads, Etc.

		160 hp. Benz.	160 hp. Mercédès.
Weight of piston, complete with rings and gudgeon pin	Lb.	5.00	6.85
Weight per sq. in. piston area	Lb.	0.2428	0.2874
Weight of connecting rod complete	Lb.	5.00	5.00
Total reciprocating weight per cylinder	Lb.	6.80	8.35
Weight per sq. in. piston area	Lb.	0.330	0.350
Length of connecting rod	In.	12.37	11.42
Ratio. Connecting rod/crank throw		3.50 : 1	3.63 : 1
Inertia. Lb. sq. in. piston area. Top center.	Lb. sq. in.	83.60	78.10
Inertia. Lb. sq. in. piston area. Bottom center	Lb. sq. in.	46.40	44.35
Inertia. Lb. sq. in. piston area. Mean	Lb. sq. in.	65.00	61.20
Weight of rotating mass of connecting rod	Lb.	3.20	3.30
Total centrifugal pressure	Lb.	633	611
Centrifugal pressure, lb. sq. in. piston area	Lb. sq. in.	30.70	25.62
Total loading due to inertia and centrifugal pressures	Lb. sq. in.	95.70	86.82
Mean average fluid pressure, including compression	Lb. sq. in.	42.50	42.20
Mean average loading on crank pin bearing, total from all sources in terms of lb. sq. in. piston area	Lb. sq. in.	116.50	108.62
Diameter of crank pin	In.	2.165	2.205
Rubbing velocity	Ft. per sec.	13.22	13.46
Effective projected area of big-end bearing	Sq. in.	4.860	5.460
Ratio. Piston area/projected area of big-end bearing		4.18 : 1	4.37 : 1
Mean average loading on big-end bearing	Lb. sq. in.	487.00	475.00

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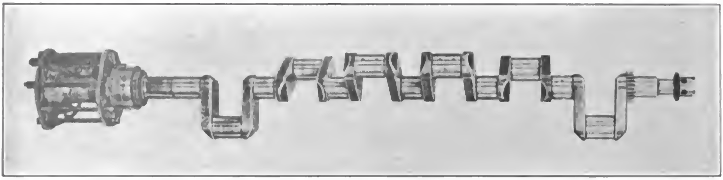
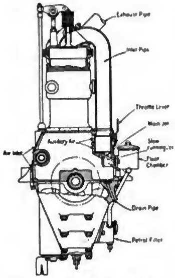
* Digest from *The Automobile Engineer*.



160 HP. Benz Crankshaft



Ignition System 160 HP. Benz Engine

characteristics in common, and differ from one another only in minor details of design. Both engines bear out plainly the German practice of sacrificing light weight to sturdiness, and, consequently, reliability; both are of the water-cooled, six-cylinder vertical type, with overhead camshaft drive, and possess double ignition and twin carbureters; and, finally, the structural parts of both engines appear to have been designed with the particular view of quantity production.

Details of design which are at variance from one another may be briefly resuméd as follows. The overhead camshaft arrangement of the Benz appears as being superior to that of the

TABLE VI.

Valve Detail.

		160 hp. Benz.	160 hp. Mercédès.
Outside diameter	In.	2.677	2.834
Port diameter	In.	2.420	2.677
Width of seating	In.	0.0787	0.0787
Radius under valve head	In.	0.3937	0.3149
Lift of valve	n.	0.433	0.440
Diameter of valve stem	In.	0.5512	0.4724
Length of valve guide	In.	2.953	2.756
Overall length of valve	In.	4.921	5.984
Number of springs per valve	No.	One	One
Free length of spring	In.	2.913	3.110
Length of spring in position, no lift	In.	1.968	2.244
Mean diameter of coils	In.	1.535 (parallel)	1.417—1.142 (taper)
Gauge of wire	No. gauge	7-8	8-9
Diameter of wire	n.	0.168	0.1575
Ratio. Length of spring/lift of valve		4.55:1	5.10:1
Weight of valve, complete with spring, cap, etc.	Lb.	0.9926	1.140
Weight of spring, bare	Lb.	0.2405	0.230

The inlet and exhaust valves are interchangeable.

TABLE IV.

160 HP. Benz Cylinder Dimensions.

Overall height of bare cylinder from top of base chamber	16.260"	
Depth of spigot at base of cylinder	0.2756"	
Diameter of cylinder over water jacket	6.417"	
Valve centres	2.756"	
Thickness of flange at base of cylinder	0.512"	
Number of holding-down studs per cylinder	Eight.	
Diameter of holding-down studs	0.394"	
Steel water jacket	No. 19 S.W.G. (0.040")	
Mean thickness of combustion chamber wall	0.2756"	
Bursting stress*	3715	lb. sq. in.
Mean thickness of cylinder barrel	0.1968"	
Tensile stress*	2604	lb. sq. in.

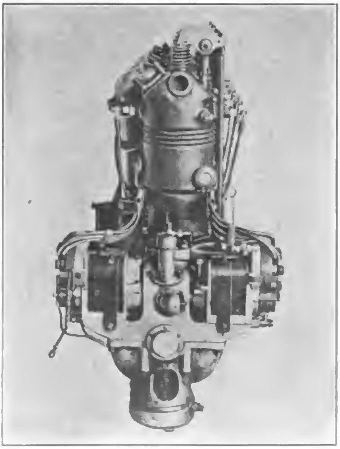
*Note.—Assumed maximum pressure following several consecutive misfire; 400 lb. per sq. in.

TABLE V.

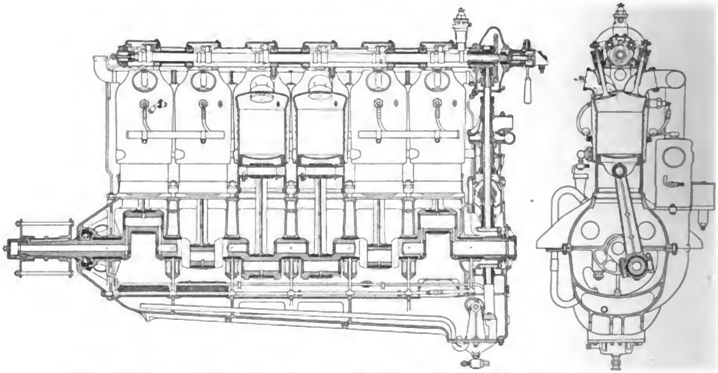
160 HP. Mercédès Cylinder Dimensions.

Overall height of bare cylinder from top of base chamber	15.270"	
Depth of spigot at base of cylinder	0.2756"	
Mean diameter of cylinder over water jacket	6.732"	
Steel water jacket	No. 18 B.W.G. (0.049")	
Mean thickness of combustion chamber wall	0.1968"	
Bursting stress*	5600	lb. sq. in.
Mean thickness of cylinder barrel	0.1132"	
Tensile stress*	4870	lb. sq. in.

*Note.—Assumed maximum pressure following several consecutive misfires· 400 lb. per sq. in.



End View of 160 HP. Benz Engine



General Arrangement of Mercédès Engine 140 mm. Bore x 160 mm. Stroke

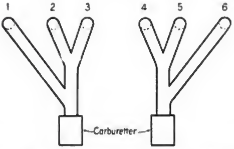


Diagram of Induction Pipe System, 160 HP. Benz Engine

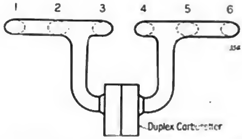
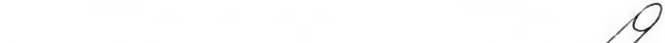
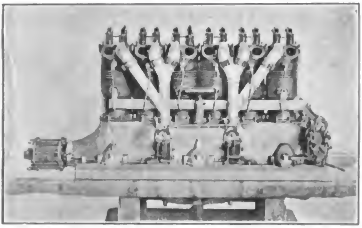


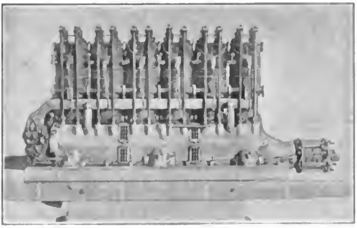
Diagram of Induction Pipe System, 160 HP. Mercédès Engine



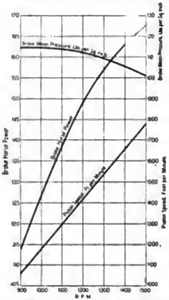
General Arrangement of Benz Engine, 130 mm Bore x 180 mm. Stroke



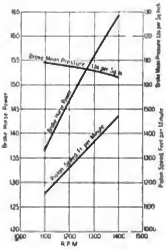
Inlet and Exhaust Side of 160 HP. Benz Engine



Off Side of the 160 HP. Benz Engine



Power Curve of 160 HP. Benz Engine



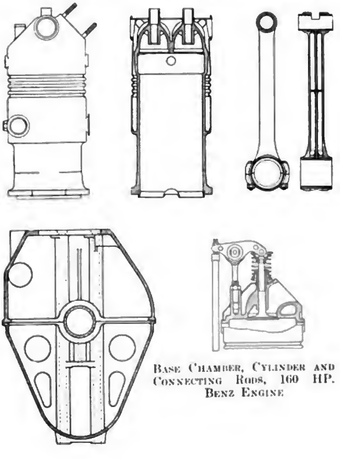
Power Curve of 160 HP. Mercédès Engine

Mercédès, because it may be more easily manufactured, and is also more accessible, although, on the other hand, the Mercédès valve gear is the better arrangement for a high-speed engine. Furthermore, greater rigidity is imparted to the engine unit in the Mercédès design, the cylinders being connected to another by the camshaft housing.

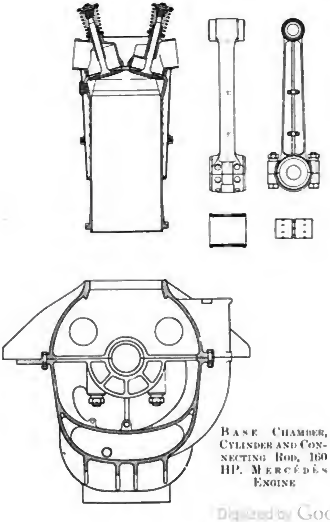
The Benz cylinders are of cast iron with built-up water jackets, the jackets being in both types sheet steel pressings welded to the cylinder heads. The pistons of the Benz are of cast iron, while those of the Mercédès are of the built-up type, comprising a forged steel head, with a cast-iron wall screwed and welded to it.

The water pipe arrangement of the Benz is particularly worthy of note in that it is reduced to a minimum and can easily be taken down.

In the accompanying dimensional comparison it has been necessary, owing to the differences in the design of the valve



Base Chamber, Cylinder and Connecting Rods, 160 HP. Benz Engine

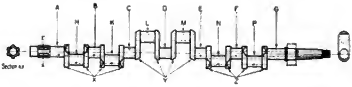


Base Chamber, Cylinder and Connecting Rod, 160 HP. Mercédès Engine

TABLE VII.

Connecting Rod and Piston.

		160 hp. Benz.	160 hp. Mercédès.
Length between centers	In.	12.37	11.42
Ratio. Connecting rod/crank throw		3.50 : 1	3.63 : 1
Little-end bearing. Type..........		Phosphor bronze bush fixed in rod	Case-hardened steel bush, floating
Little-end bearing. Diameter......	In.	1.180	1.299
Little-end bearing. Length.........	In.	2.910	2.933
Little-end bearing. Projected area...	Sq. in.	3.435	3.810
Ratio. Piston area/projected area of little-end bearing................		6.00 : 1	6.26 : 1
Big-end bearing. Type............		White metal direct in rod	Bronze shell, lined white metal
Big-end bearing. Diameter........	In.	2.165	2.205
Big-end bearing. Length (actual)...	In.	2.640	2.874
Big-end bearing. Length (effective)	In.	2.244	2.480
Big-end bearing. Projected area (effective)....................	Sq. in.	4.860	5.460
Ratio. Piston area/projected area of big-end bearing...............		4.18 : 1	4.37 : 1
Number of big-end bolts...........	No.	Four	Two
Full diameter of bolts..............	In.	0.3937	0.5315
Total cross sectional area bottom of threads......................	Sq. in.	0.372	0.350
Maximum load due to inertia at 1400 r.p.m....................	Lb.	1720	1862
Maximum load due to inertia at 1600 r.p.m....................	Lb.	2242	2432
Load due to centrifugal force at 1400 r.p.m....................	Lb.	434.5	487
Load due to centrifugal force at 1600 r.p.m....................	Lb.	567.5	636
Total load on bolts at 1400 r.p.m....	Lb.	2154.5	2349
Total load on bolts at 1600 r.p.m....	Lb.	2809.5	3068
Stress per sq. in. at 1400 r.p.m......	Lb. sq. in.	5790	6710
Stress per sq. in. at 1600 r.p.m......	Lb. sq. in.	7540	8770



Crankshaft 160 HP. Mercédès Engine

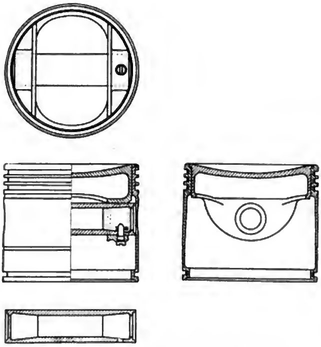
TABLE VIII.

Crankshaft.

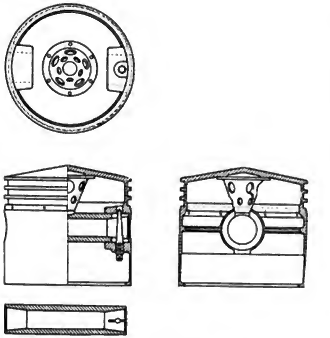
		160 hp. Benz.	160 hp. Mercédès.
Length of complete shaft....................	In.	—	58.48
Cylinder centers............................	In.	6.690	7.007
Cylinder centers (center pair)................	In.	6.690	7.007
Outside diameter of crank pin	In.	2.165	2.205
Inside diameter of crank pin.................	In.	1.1024	1.26 (mean)*
Length of crank pin........................	In.	2.716	2.913
Outside diameter of journals................	In.	2.165†	2.125
Inside diameter of journals..................	In.	1.1024	1.16 (mean)*
Number of journal bearings..................	No.	Seven	Seven
Length of journal bearings. Propeller end...	In.	2.756	3.543
Length of journal bearings. Rear end.......	In.	1.968	2.992
Length of journal bearings. Center.........	In.	2.2047	2.2835
Length of journal bearings. Intermediate....	In.	2.2047	2.2835
Width of crank webs........................	In.	2.598	2.677 (mean)*
Thickness of crank webs	In.	0.945	0.905 (mean)*
Radius at ends of journals and crank pins....	n.	0.197	0.1575
Diameter of drilled oilways in shaft..........	In.	0.1575	0.1575
Weight of complete shaft.....................	Lb.	72.70	70.00

* See Table IX. for dimensions of individual crank pins and journals.

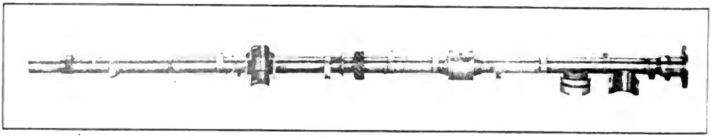
† Except rear journal, which is 1.889" diameter.



160 HP. Mercédès Piston and Gudgeon Pin



160 HP. Benz Piston and Gudgeon Pin



The Benz Camshaft

gear, to make some adjustments in weights in order to bring the engines in line for purposes of comparison. The principal alteration consists in including the weight of the camshaft housing, camshaft bearing, etc., of the Mercédès engine in the top half of the base chambers.

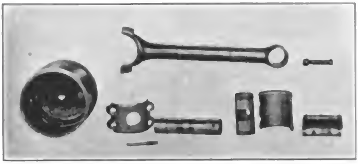
TABLE IX.

Applies to 160 HP. Mercédès Crankshaft Only.

R. = Ratio. External diameter. Internal diameter.

Description.	Dimensions. In.	R.
Outside diameter of all journals	2.126	—
Inside diameter of journal. A	1.535	1.385/1
Inside diameter of journal. B	1.338	1.588/1
Inside diameter of journal. C	1.220	1.742/1
Inside diameter of journal. D	1.102	1.930/1
Inside diameter of journal. E	0.984	2.161/1
Inside diameter of journal. F and G	0.787	2.702/1
Length of journal. A	3.071	—
Length of journal. B, C, and D	2.2835	—
Length of journal. E	2.244	—
Length of journal. F	2.204	—
Length of journal. G	3.543	—
Outside diameter of all crank pins	2.205	—
Inside diameter of crank pin. H	1.456	1.514/1
Inside diameter of crank pin. K	1.338	1.647/1
Inside diameter of crank pin. L	1.220	1.807/1
Inside diameter of crank pin. M, N, and P	1.102	2.00/1
Width of crank webs. X	2.598	—
Width of crank webs. Y	2.677	—
Width of crank webs. Z	2.756	—
Thickness of crank webs. X and Y	0.905	—
Thickness of crank webs. Z*	0.945	—

* Except end web at propeller end, which is 1.023" thick.



160 HP. Benz Piston and Connecting Rod Assembly

TABLE X.

Miscellaneous Weights.

	160 hp. Benz. Lb.	160 hp. Mercédès. Lb.
One cylinder complete, less valves	26.00	19.25
Connecting rod complete	5.00	5.00
Piston, complete with rings and gudgeon pin	5.00	6.85
Valve, complete with spring	0.992	1.140
Valve complete, less spring	0.758	0.910
Valve rocker complete	0.436	0.495
Valve tappet complete, less guide	0.211	—
Valve push rod complete	0.535	—
Weight of engine complete, less cooling system, fuel, oil, and tanks	591.50	618.00
Weight per normal ground level B.H.P.	3.70	3.80
Weight of engine complete, including cooling system at 0.65 lb. ground level B.H.P.	695.50	723.60
Weight per normal ground level B.H.P.	4.35	4.45
Weight of engine complete, including cooling system, fuel, oil, and tanks for four hours (fuel and oil allowance at rate of ground level B.H.P., and tanks at rate of 10% of weight of fuel and oil)	1083.30	1121.75
Weight per normal ground level B.H.P.	6.77	6.90

TABLE Xa.

General Analysis of Weights.

Description.	160 hp. Benz.		160 hp. Mercédès.		Average.
	Lb.	Percentage of Total Weight.	Lb.	Percentage of Total Weight.	Percentage of Total Weight.
Cylinders	168.00	28.40	115.50	18.71	23.555
Base Chamber. Top half	100.00	16.92	118.59	19.21	18.065
Base Chamber. Bottom half	65.75	11.10	73.00	11.82	11.461
Crankshaft complete	72.70	12.28	70.00	11.33	11.806
Propeller hub, complete	12.00	2.06	13.00	2.10	2.080
Propeller thrust race, complete	3.81	0.64	2.56	0.42	0.530
Camshaft, complete	10.50	1.78	10.50	1.63	1.706
Pistons complete including gudgeon pin	30.00	5.07	41.10	6.66	5.866
Connecting rods, complete	30.00	5.07	30.00	4.85	4.960
Valves, complete	11.91	2.01	13.68	2.21	2.110
Valve operating gear between cam and valve stem	14.20	2.40	5.94	0.96	1.680
Induction pipes, complete	8.125	1.37	11.75	1.90	1.635
Carbureters, complete	7.25	1.22	12.73	2.06	1.640
Magnetos, complete	29.00	4.91	30.00	4.86	4.886
Ignition wiring, complete with cable tubes	4.35	0.73	4.00	0.65	0.690
Water pump, complete	4.81	0.81	6.87	1.11	0.960
Water pipes	3.00	0.51	19.00	3.08	1.795
Oil pump, complete	4.55	0.77	12.00	1.94	1.355
Air pump, complete	1.125	0.19	1.50	0.24	0.215
Miscellaneous	10.42	1.76	26.28	4.26	3.005
Total	591.50	100.00	618.00	100.00	100.000

Aeronautical Patents

OCTOBER 9, 1917

1,242,295. To Daniel M. Willard, Bakersfield, Cal., assignor of one-half to Albert J. Mills, Bakersfield, Cal. Flying machine.
1,242,412. To Robert D. Andrews, Brookline, Mass. Flying apparatus.
1,242,540. To Walter R. Fuller, Atlanta, Ga. Airplane.
1,242,553. To Benton H. Jackson, Dayton, Wash. Means for dropping projectiles from air craft.
1,242,766. To James M. Butcher, Chicago, Ill. Airship.

ISSUED OCTOBER 16, 1917

1,243,556—To John J. Reynolds and Arthur Jenkins, Ruleville, Miss. Cargo structure for aircraft.
1,243,557—To John J. Reynolds, Rantoul, Ill. Air pressure-maintenance chamber for aircraft.

ISSUED OCTOBER 23, 1917

1,244,129—To Adolph Ranson, South Charleston, W. Va., assignor of one-half to Stanton Isaac, South Charleston, W. Va. Parachute.
1,244,367—To Prokop Jack Prokop, New York, N. Y. Airship.

ISSUED OCTOBER 30, 1917

1,244,470—To Anders J. Christensen, Hempstead, N. Y. Airplane construction and the like.

ISSUED NOVEMBER 6, 1917

1,245,279—To William H. V. Shrum, Columbus, Ohio. Boomerang.
1,245,389—To Henry W. Schmidt, Edgewater, N. J. Aeronautical apparatus.
1,245,724—To Henry W. Jacobs and Raffe Emerson, Topeka, Kans. Airplane.
1,245,902—To Frank Gretsky, Coal Center, Pa. Airplane motor.
1,246,010—To William Starling Burgess, Marblehead, Mass., assignor to the Curtiss Aeroplane & Motor Corp. Inherently-stable flying boat.
1,246,011—To Glenn H. Curtiss, Hammondsport, N. Y., assignor to the Curtiss Motor Co., Hammondsport, N. Y. Flying boat.
1,246,012—To Glenn H. Curtiss, Hammondsport, N. Y., assignor to The Curtiss Motor Co., Hammondsport, N. Y. Flying boat.
1,246,013—To Glenn H. Curtiss and Henry Kleckler, Hammondsport, N. Y., assignors to the Curtiss Motor Co., Hammondsport, N. Y. Balancing system for aircraft.
1,246,015—To Glenn H. Curtiss, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Airplane.
1,246,016—To Glenn H. Curtiss, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Flying boat.
1,246,018—To Glenn H. Curtiss, Buffalo, N. Y., assignor to the Curtiss Aeroplane & Motor Corp. Draft system for flying boats.
1,246,019—To Glenn H. Curtiss, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Flying-boat hull.

International Aircraft Standards

(Continued from last issue.)

3S25- Specifications for Extra Soft Carbon Steel Sheet

General.—1. The general specifications, 1G1, shall form, according to their applicability a part of these specifications.

Material.—2. The material for these sheets shall be chosen from the I. A. S. B. standard steels listed below. The composition shall be stated by the manufacturer or contractor, and is further limited as follows: Carbon, not over 0.15 per cent.

Manufacture.—3. (*a*) The steel shall be manufactured, or at least finished, by the open-hearth, electric-furnace or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) Sheets, unless ordered cold rolled, shall be full pickled.

Heat Treatment.—(*d*) Sheets are to be well and uniformly annealed in accordance with good commercial practice. For sheets lighter than 0.065 in. (1.65 mm.), box annealing is preferred. For sheets 0.065 in. (1.65 mm.) and thicker, open annealing is preferred.

Workmanship and Finish.—4. (*a*) The sheets must be commercially flat, clean, smooth, free from seams, laminations, blisters, and other surface defects. They must be uniform in quality, and within the stipulated margins of manufacture.

(*b*) Any sheet may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously been accepted by the inspector; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—5. (*a*) Specimens cut in any direction from the sheets shall have the following properties:

Tensile Test.—(*b*) Minimum tensile strength, 50,000 lb. per sq. in. (35.2 kg.) mm.^{2}); minimum yield point, 30,000 lb. per sq. in. (21.09 kg./mm.^{2}; minimum elongation 25 per cent in 4 in. (101.6 mm.).

Bend Test.—(*c*) Strips cut from sheets shall stand being bent cold through an angle of 180 deg. in any direction to a radius equal to the thickness of the sheet without fracture.

(*d*) Strips 1¼ in. (31.75 mm.) wide cut from sheets and with edges rounded shall stand reverse bending, cold, through an angle of 90 deg. for not less than three complete reversals, without fracture. The test is to be made in a square-nose vise, the edges over which the specimen is bent being rounded to a radius equal to three times the thickness of the sheet.

Selection of Test Specimens.—6. Three sheets shall be taken from each annealing box to represent the top, middle, and bottom of the stack, or 1 sheet from each 25 when sheets are open annealed. One tensile, one bend, and one reverse bending test shall be made from each sheet selected.

Dimensions and Tolerances.—7. The dimensions and tolerances shall be those given in the table below and in the specifications 3S11. The thickness will be specified in decimals of an inch or millimeters.

Delivery, Packing, and Shipping.—8. (*a*) Sheets shall be cut to the required dimensions and shall be ordered in as narrow widths as can be used.

(*b*) All sheets shall be oiled for protection against corrosion.

(*c*) Sheets 0.065 in. (1.65 mm.) or thinner shall be boxed, the weight of box with contents not to exceed 220 lb. (100 kg.).

(*d*) Sheets thicker than 0.065 in. (1.65 mm.) up to and including 0.125 in. (3.18 mm.), shall be crated, the weight of crate and contents not to exceed 220 lb. (100 kg.).

(*e*) Sheets thicker than 0.125 in (3.18 mm.) may be bundled, the weight of bundle not to exceed 220 lb. (100 kg.).

COMPOSITION OF STANDARD STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.
1010	0.05-0.15	0.30-0.60	0.045	0.050

When electric or crucible steel is specified in the order, the maximum allowable percentage of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

TABLE OF TOLERANCES FOR STANDARD STEEL SHEETS.

Thickness.		Tolerance for sheets 14 inches (35.6 cm.) wide and under.		Tolerance for sheets over 14 inches (35.6 cm.) wide.	
Inches.	*Millimeters.*	*Inches.*	*Millimeters.*	*Inches.*	*Millimeters.*
0-0.020	0.51	+0.001 − .002	+0.03 − .05	±0.002	±0.05
0.021- .030	0.54- .76	+ .002 − .003	+ .05 − .08	± .003	± .08
.031- .040	.79-1.02	± .003	± .08	± .003	± .08
.041- .050	1.05-1.27	± .003	− .08	± .004	± .10
.051- .065	1.30-1.65	± .004	± .10	± .004	± .10
.066- .080	1.68-2.03	± .004	± .10	± .005	± .13
.081- .100	2.06-2.54	± .006	± .15	± .006	± .15
.101- .120	2.57-3.05	± .006	± .15	± .007	± .18
.121- .250	3.08-6.35	± .006	± .15	± .008	± .20

3N11—Specifications for Aluminum Alloy Castings

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Use.—2. Two alloys are described.

Alloy 1 is suitable for crank cases and general purposes for which tensile strength is required.

Alloy 2 is suitable for die castings for bearing surfaces and pistons for use at higher temperatures.

Material.—3. (*a*) These alloys shall have the following compositions:

	Alloy No. 1.	Alloy No. 2.
Specific gravity	2.89	2.95.
Copper	7.0 to 8.5 per cent	9.25 to 10.75 per cent.
Impurities	Not over 1.7 per cent	Not over 1.7 per cent.
Aluminum	Balance	Balance.

(*b*) Ingot aluminum of grades Standard No. 1 and Standard No. 2 may be used in making these alloys.

Workmanship and Finish.—4. (*a*) The castings are to be clean, sound, and free from blowholes, misruns, cracks, shrinks, and similar defects.

(*b*) No repairing, plugging, or welding will be allowed unless previous permission in writing has been obtained from the inspector; such permission will only be given when the defects to be repaired are small and do not affect the strength of the casting.

Physical Properties and Tests.—5. (*a*) The alloys shall have the following minimum physical properties:

Tensile Test.—

	Alloy No. 1, sand cast.	Alloy No. 2, sand or die cast.
Tensile strength	18,000 pounds per square inch (12.65 kg./mm.^{2}).	18,000 pounds per square inch (12.65 kg./mm.^{2}).
Elongation in 2 inches (50.8 mm.)	1.5 per cent	

(*b*) These alloys when poured hot into very thin difficult sections, such as crankcase pans, carburetors, and manifolds, shall not be required to show a greater tensile strength than 14,000 lb. per square inch (9.84 kg./mm.^{2}).

Selection of Test Specimens.—6. (*a*) At least one sample is to be cast to represent each crank case or other large casting; this is to be attached to the casting; no chills may be applied to the test specimen.

(*b*) The number of test samples for smaller castings is left to the discretion of the inspector, who is to satisfy himself that the quality of the metal used is satisfactory and uniform.

(*c*) The latter samples are to be cast separate, but also in sand and without the use of chills.

Dimensions and Tolerances.—7. (*a*) The castings are to be accurately in accordance with the drawings, and sufficient allowance is to be made to enable them to be machined where required to the finished dimensions without leaving evidence of the cast surface.

(*b*) A tolerance of 3 per cent is allowed in the weight of the individual castings.

3S27—Specifications for One-Half Hard Carbon Steel Sheet

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. The material for these sheets shall be chosen from the I. A. S. B. standard steels listed below. The composition shall be stated by the manufacturer or contractor, and is further limited as follows: Carbon, not over 0.40 per cent; manganese may be from 0.30 to 0.60 per cent.

Manufacture.—3. (*a*) The steel shall be manufactured, or at least finished, by the open-hearth, electric-furnace, or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) Sheets, unless ordered cold rolled, shall be full pickled.

Heat Treatment.—(*d*) Sheets are to be well and uniformly annealed, in accordance with good commercial practice. For sheets lighter than 0.065 in (1.65 mm.), box annealing is preferred. For sheets

0.065 in. (1.65 mm.) and thicker, open annealing is preferred.

Workmanship and Finish.—4. (*a*) The sheets must be commercially flat, clean, smooth, free from seams, laminations, blisters, and other surface defects. They must be uniform in quality, and within the stipulated margins of manufacture.

(*b*) Any sheet may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously been accepted by the inspector; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—5. (*a*) Specimens cut in any direction from the sheets shall have the following properties:

Tensile Test.—(*b*) Minimum tensile strength, 75,000 lb. per sq. in. (52.73 kg./mm.²); minimum yield point, 45,000 lb. per sq. in. (31.64 kg./mm.²); minimum elongation, 18 per cent in 4 in. (101.6 mm.).

Bend Test.—(*c*) Strips cut from sheets shall stand being bent cold through an angle of 180 deg. in any direction to a radius equal to the thickness of the sheet without fracture.

(*d*) Strips 1¼ in. (31.75 mm.) wide cut from sheets and with edges rounded shall stand reverse bending, cold, through an angle of 90 deg. for not less than three complete reversals, without fracture. The test is to be made in a square-nose vise, the edges over which the specimen is bent being rounded to a radius equal to three times the thickness of the sheet.

Selection of Test Specimens.—6. Three sheets shall be taken from each annealing box to represent the top, middle, and bottom of the stack, or 1 sheet from each 25 when sheets are open annealed. One tensile, one bend, and on reverse bending test shall be made from each sheet selected.

Dimensions and Tolerances.—7. The dimensions and tolerances shall be those given in the table below and in the specifications 3S11. The thickness will be specified in decimals of an inch or millimeters.

Delivery, Packing, and Shipping.—8. (*a*) Sheets shall be cut to the required dimensions and shall be ordered in as narrow widths as can be used.

(*b*) All sheets shall be oiled for protection against corrosion.

(*c*) Sheets 0.065 in (1.65 mm.) or thinner, shall be boxed, the weight of box with contents not to exceed 220 lb. (100 kg.)

(*d*) Sheets thicker than 0.065 in. (1.65 mm.), up to and including 0.125 in. (3.18 mm.), shall be crated, the weight of crate and contents not to exceed 220 lb. (100 kg.).

(*e*) Sheets thicker than 0.125 in. (3.18 mm.), may be bundled, the weight of bundle not to exceed 220 lb. (100 kg.).

CHEMICAL COMPOSITION OF STANDARD STEEL.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur maximum.
1030	0.25–0.35	0.50–0.80	0.045	0.050
1035	.30– .40	.50– .80	.045	.050

When electric or crucible furnace steel is specified in the order, the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

TABLE OF TOLERANCES FOR STANDARD STEEL SHEETS.

Thickness.		Tolerance for sheets 14 inches (35.6 cm.) wide and under.		Tolerance for sheets over 14 inches (35.6 cm.) wide.	
Inches.	*Millimeters.*	*Inches.*	*Millimeters.*	*Inches.*	*Millimeters.*
0–0.020	0.51	+0.001 − .002	+0.03 − .05	±0.002	±0.05
0.021– .030	0.54– .76	+ .002 − .003	+ .05 − .08	± .003	± .08
.031– .040	.79–1.02	± .003	± .08	± .003	± .08
.041– .050	1.05–1.27	± .003	+ .08	± .004	± .10
.051– .065	1.30–1.65	± .004	± .10	± .004	± .10
.066– .080	1.68–2.03	± .004	± .10	± .005	± .13
.081– .100	2.06–2.54	± .006	± .15	± .006	± .15
.101– .120	2.57–3.05	± .006	± .15	± .007	± .18
.121– .250	3.08–6.35	± .006	± .15	± .008	± .20

3S26—Specifications for Soft Carbon Steel Sheet

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. The material for these sheets shall be chosen from the I. A. S. B. standard steels listed below. The composition shall be stated by the manufacturer or contractor, and is further limited as follows: Carbon, not over 0.30 per cent; manganese may be from 0.30 to 0.60 per cent.

Manufacture.—3. (*a*) The steel shall be manufactured, or at least finished, by the open-hearth, electric-furnace, or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) Sheets, unless ordered cold rolled, shall be full pickled.

Heat Treatment.—(*d*) Sheets are to be well and uniformly annealed, in accordance with good commercial practice. For sheets lighter than 0.065 in. (1.65 mm.), box annealing is preferred. For sheets 0.065 in. (1.65 mm.) and thicker, open annealing is preferred.

Workmanship and Finish.—4. (*a*) The sheets must be commercially flat, clean, smooth, free from seams, laminations, blisters, and other surface defects. They must be uniform in quality, and within the stipulated margins of manufacture.

(*b*) Any sheet may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously been accepted by the inspector; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—5. (*a*) Specimens cut in any direction from the sheets shall have the following properties:

Tensile Test.—(*b*) Minimum tensile strength, 60,000 lb. per sq. in. (42.18 kg. mm.$_2$); minimum yield point, 36,000 lb. per sq. in. (25.31 kg. mm.$_2$); minimum elongation, 22 per cent in 4 in. (101.6 mm.).

Bend Tests.—(*c*) Strips cut from sheets shall stand being bent cold through an angle of 180 deg. in any direction to a radius equal to the thickness of the sheet without fracture.

(*d*) Strips 1¼ in. (31.75 mm.) wide cut from sheets and with edges rounded shall reverse bending, cold, through an angle of 90 deg. for not less than three complete reversals without fracture. The test is to be made in a square-nose vise, the edges over which the specimen is bent being rounded to a radius equal to three times the thickness of the sheet.

Selection of Test Specimens.—6. Three sheets shall be taken from each annealing box to represent the top, middle, and bottom of the stack, or one sheet from each 25, when sheets are open annealed. One tensile, one bend, and one reverse bending test shall be made from each sheet selected.

Dimensions and Tolerances.—1. (*a*) The dimensions and tolerances shall be those given in the table below and in the specifications 3S11. The thickness will be specified in decimals of an inch or millimeters.

Delivery, Packing, and Shipping.—8. (*a*) Sheets shall be cut to the required dimensions and shall be ordered in as narrow widths as can be used.

(*b*) All sheets shall be oiled for protection against corrosion.

(*c*) Sheets 0.065 in (1.65 mm.) or thinner shall be boxed, the weight of box with contents not to exceed 220 lb. (100 kg.).

(*d*) Sheets thicker than 0.065 in. (1.65 mm.), up to and including 0.125 in. (3.18 mm.), shall be crated, the weight of crate and contents not to exceed 220 lb. (100 kg.).

(*e*) Sheets thicker than 0.125. in (3.18 mm.) may be bundled, the weight of bundle not to exceed 220 lb. (100kg.).

COMPOSITION OF STANDARD STEELS

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur maximum.
1020	0.15–0.25	0.30–0.60	0.045	0.050
1025	.20– .30	.50– .80	.045	.050

When electric or crucible furnace steel is specified in the order, the maximum allowable percentage of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

TABLE OF TOLERANCES FOR STANDARD STEEL SHEETS.

Thickness.		Tolerance for sheets 14 inches (35.6 cm.) wide and under.		Tolerance for sheets over 14 inches (35.6 cm.) wide.	
Inches.	*Millimeters.*	*Inches.*	*Millimeters.*	*Inches.*	*Millimeters.*
0–0.020	0.51	+0.001 − .002	+0.03 + .05	±0.002	±0.05
0.021– .030	0.54– .76	+ .002 − .003	+ .05 − .08	± .003	± .08
.031– .040	.79–1.02	± .003	± .08	± .003	± .08
.041– .050	1.05–1.27	± .003	− .08	± .004	± .10
.051– .065	1.30–1.65	± .004	± .10	± .004	± .10
.066– .080	1.68–2.03	± .004	± .10	± .005	± .13
.081– .100	2.06–2.54	± .006	± .15	± .006	± .15
.101– .120	2.57–3.05	± .006	± .15	± .007	± .18
.121– .250	3.08–6.35	± .006	± .15	± .008	± .20

Digest of the Foreign Aeronautical Press

Aeronautics (London), October 24, 1917

The Air Offensive.—With a view to the great air offensive in the spring, the Germans have been content to allow their program of aircraft construction to be announced to the world through a neutral medium. They are about, it appears, to launch forth on construction and design to the uttermost limit of their manufacturing resources. They intend, according to this source of information, to concentrate on the production of four main types of machines: the fighting single-seater scout, the two-seater reconnaissance fighter with long radius of action, the long-distance bomber, and the infantry-fighter, or contact patrol airplane.

POWER-UNIT OF A FRENCH AIRSHIP

Passed by Committee on Public Information
Photo Central News Photo Service

Of the first type the Germans already possess an abundance; heavily-engined, of excellent flying performance, their fighting scouts and escorts are almost the equal of ours. And that slight degree of superiority which we manage to maintain is due perhaps to the personal ascendency of our our flying men.

In the fighter-reconnaissance airplane we have a clear superiority, provided the authorities exercise clear judgment in their orders now—for our present orders of machines will determine our success six months hence. It should not be forgotten, though only too often it is, that an aerial program involving material production requires months for its elaboration, let alone for its execution. Machines have to be built—which means that designers have to be instructed, materials provided, whole technical staffs trained in their special jobs, and pilots and the remaining personnel trained in their various duties. All of which takes time, even with the best will and the most efficient means in the world. Those who lightly speak of an aerial offensive on a grand scale, of fleets of hundreds of bombing planes, as a rule little realize the enormous amount of preparatory work and the length of time required for the attainment of this object.

In long-distance bombers we should again hold the upper hand, again assuming a modicum of clear thinking on the part of authority. But let this be said: if our offensive in the air is to succeed, we require bombing machines capable of use in daylight raids apart from night-bombers and in day bombers in order to be successful and to be capable of operating far from their base (that is, so as to be able to dispense with escort) have to be exceptionally speedy and possess a high "ceiling."

In the matter of infantry-fighters we are less clear, if only for the reason that we are still in the purely experimental stage. Contract patrol work was originated a year ago on the Somme. We were the first to adopt it; there is reason to believe that we shall be first in perfecting it. But the Boche has the inventive faculty full well developed; wherefore it behooves us to consider whether his scheme of a slow, heavily-armored, bullet-proof trench-fighter is not worthy of adoption.

Meanwhile it is quite clear that the Boche is pinning his faith to next spring's aerial offensive. It is also clear that he is laying his plans now, as he perforce must do. If we are to counter him, and do so effectively, we must also start to plan straight away. Otherwise we shall be in for a hard time next spring, and London, to consider only one aspect of the matter, will be no health resort. In war, as in physic, there is only one maxim that commands success: exterminate microbes before they attack you.

Some Notes on the Airscrew and the Problem of the Optimum Diameter.—By E. P. King, B.Sc. (Eng.), London.—A paper discussing the best diameter of airscrews for particular sets of conditions which are determined by the power and speed of the engine, the speed of the aircraft and the type of propeller used. Diagrams giving the efficiency curves, thrust curves, torque curves, etc., of a 250-hp. propeller accompany the article.

The Aeroplane (London), October 17, 1917

The Commander of the Defenses of London.—The Defenses of London are under the command of Maj.-Gen. E. B. Ashmore, C.B., M.V.O.

General Ashmore was born on Feb. 20, 1872, in London, and after a highly distinguished career in the Royal Regiment of Artillery he attained his majority on April 19, 1909. He learned to fly on a Bristol biplane at Brooklands, his certificate being No. 281, dated Sept. 3, 1912, so that as an aviator he is closely contemporary with General Salmond. He served as a G.S.O. in the Directorate of Military Aeronautics, and went to France with the R.F.C. at the outbreak of war.

On Nov. 18, 1914, he was gazetted temporary lieutenant-colonel, as a wing-commander, R.F.C., and later on was promoted to brigadier-general.

Aeronautics (London), October 17, 1917

The New High Command for the R.F.C.—On Oct. 12 the Secretary of the War Office made an announcement to the effect that "Lieut.-Gen. Sir David Henderson, K.C.B., D.S.O., having been deputed to undertake special work, has been lent for such service, and has thereby vacated his seat on the Army Council.

"The Secretary of State for War has appointed Maj.-Gen. J. M. Salmond as his successor as Director-General of Military Aeronautics, with a seat on the Army Council.

"Major-General Brancker, at present Deputy Director of Military Aeronautics, has been appointed to a command abroad, and for the present his place will not be filled."

Lieut.-Gen. Sir David Henderson, K.C.B., D.S.O., will live in history as the chief of the Flying Corps during the critical first three years of war and the years immediately preceding it. Born in 1862, he entered the Argyll and Sutherland Highlanders in 1882. In the South African War he was wounded at Ladysmith, and subsequently became Director of Military Intelligence. His connection with aviation dates back to 1911, when as Brigadier-General Henderson he took his pilot's certificate at Brooklands. In 1912, the period of the Military Trials on Salisbury Plain, he took over the command of the Royal Flying Corps, then recently formed, and nominally became Director of Military Training at the War Office. A year later he was appointed Director-General of Military Aeronautics and colonel commanding the Royal Flying Corps.

Maj.-Gen. John Maitland Salmond, C.M.G., D.S.O., who succeeds him, was born on July 17, 1881, son of a well-known military family. From Wellington he passed in 1901 into the Royal Lancaster Regiment and received his captaincy in 1910. He served through the South African War and other minor campaigns, and took his pilot's certificate in 1912. The same year he was appointed instructor at the Central Flying School at Upavon. On May 31, 1913, he was gazetted squadron commander, and for the first two years of the war served with distinction in France and Flanders as wing commander, winning the D.S.O. and three mentions in dispatches. Successively lieutenant-colonel and brigadier-general in 1916, he was gazetted major-general on June 22, 1917.

News of the Fortnight

Appointment of Aircraft Board Expected

According to Howard E. Coffin, acting chairman of the new Aircraft Board, the three civilian members will be announced within a day or two. Already the Army and Navy representatives have been announced by the Secretary of War and the Secretary of the Navy, respectively, and it only remains for the President to appoint the three civilian members. Rumor has had it for some little time that Richard F. Howe, formerly treasurer of the International Harvester Co., has been appointed as one of the three civilian members. On Nov. 20 the New York *Times* printed a Washington dispatch, in which it was stated that this appointment had been made. AVIATION AND AERONAUTICAL ENGINEERING then communicated with the White House office on the long distance telephone and is informed that the civilian appointments have not as yet been announced, and that no suggestion as to who they may be can be made at this time. The work of the board, which is to supervise the production of airplanes and accessories, is, however, still going forward under the old board, of which Mr. Coffin is chairman.

Mr. Coffin announced recently that the work of the board was keeping up to schedule, and that fine progress was being made. While no Liberty engines are yet being delivered in quantity, several plants are turning out a few each week, and by January it is expected that both engines and airplanes will be manufactured and delivered in large quantities.

"Preparations for the training of the American aviators after they leave the ground schools are also progressing exactly according to schedule, for the construction of the big training schools and flying fields in various parts of the United States which are not already in full operation are nearing completion," said Mr. Coffin. "Whereas a number of these partly trained student aviators have been sent abroad for their final instruction in the past, in the near future they will probably all be trained in this country," he continued. It was learned that instructors from the front will return here, or be detailed, to teach them all the finer points of flying, observing and fighting in the air.

There seems to be no way in which to estimate the number of student aviators training in this country, or the number sent abroad, but it is fair to assume that the Signal Corps has kept pace with the schedule set early in the year in the same manner that the Air Board has kept up the production of airplanes.

It was learned from the Council of National Defense that the new Motor Car Industry Committee is doing good work, and that the purpose of this committee, like that of all the industrial committees, is to keep idle manufacturing plants or industries not producing to full capacity in touch with the needs and demands of the Government. Where Government work is being taken over it was being done gradually in order that no hardship on the plant or company will be worked so that the decrease in the general or regular productions will not be felt in the market. In other words, a gradual conversion is being carried out so that eventually an increased percentage of the Government work may be handled without curtailing the regular output of a certain article or type of article. Little trouble with any of the Government production is anticipated, and even now the industrial committees report that the work is ahead of the program.

Foreign Airplanes on Exhibition

Among the exhibits at the "Hero Land" bazaar, which opened at Grand Central Palace, New York, on Nov. 17, is one of the fifty-four German airplanes brought down by the late Capt. Georges Guynemer, the famous French aviator. Several French planes, the wreckage of a Zeppelin which tried to bomb Buckingham Palace, a Fokker airplane brought down on the western front by a British aviator, and exploded and unexploded air bombs are also on exhibition.

Wright Monument in France

The committee appointed before the war to arrange for the erection at Le Mans, France, of a monument to Wilbur Wright, has decided to proceed immediately with the work. It is understood that the monument will be erected on the Camp of Auvours, where Wilbur Wright first demonstrated, in 1908, his airplane to the French public.

Advisory Committee Opposes Aero Shows

The National Advisory Committee for Aeronautics is opposed to the holding of aeronautical expositions during the period of the war. By formal resolution, it has approved the action of the Aircraft Board, which has announced that as a matter of general policy in view of the military situation it does not encourage the holding of any expositions of aircraft for the duration of the war.

For military reasons no developments of new types of engines or planes can be exhibited and the inevitable distraction of interest on the part of manufacturers would not be in the interest of the military departments.

The National Advisory Committee for Aeronautics gave the question careful consideration at a recent meeting, after which the following resolution was passed:

"Resolved, That the action of the Aircraft Board on the subject of aeronautical expositions during the war be approved by the National Advisory Committee for Aeronautics and that the Aircraft Board and the Manufacturers Aircraft Association be notified of this action."

National Committee on Civil Aerial Transport

The National Advisory Committee for Aeronautics announced on Nov. 20 the establishment of a Committee on Civil Aerial Transport. This committee supersedes the former committee on Aerial Mail Service and has far broader scope and functions.

The functions of the Civil Aerial Transport Committee will include, in addition to those formerly exercised by the Committee on Aerial Mail Service, the problems connected with the application of aircraft to civil purposes, the utilization of military airplanes and aviators after the war for such purposes, and co-operation with similar organizations of other nations.

The organization of this new committee is as follows:

Dr. W. F. Durand, chairman, chairman of the National Advisory Committee for Aeronautics.

Dr. S. W. Stratton, secretary of the National Advisory Committee for Aeronautics, and director of the United States Bureau of Standards.

Prof. Charles F. Marvin, chief of the United States Weather Bureau.

Lieut.-Col. V. E. Clark, Signal Corps, U. S. A.

Lieut. Commander J. H. Towers, U. S. N.

All of the above are members of the National Advisory Committee for Aeronautics.

In accordance with regulations, which have been approved by the President, additional members may be added from time to time as the work of the committee develops.

Comprehensive plans will be formulated as soon as practicable, but it is not planned to divert agencies of military value to the development of civil aeronautics until after the war.

Lloyd George on the Airplane Situation

Addressing members of the American War Mission and his followers among the leading representatives of the British Government at an historic conference held in Downing Street, on Nov. 20, on the prosecution of the war, Premier Lloyd George emphasized the importance of the American shipbuilding and military programs.

Dealing with the airplane situation, the Premier said: "Command of the air in the battle line is almost as essential as command of the sea. The people of the United States possess to an unusual degree the qualities of enterprise and daring necessary to the creation of successful aviators. The American climate also lends itself to the development of the air service, because it is clearer and more equable than the climate of the British Isles. This is of special value, because the training of pilots, the creation of flying units and the building of aerodromes are as essential to the creation of an air service as the building of airplanes themselves."

Liberty Engine Breaks Auto Record

Ralph De Palma, veteran auto speed driver, made a new record on Nov. 16, at Sheepshead Bay Speedway, New York, when he drove a Packard car fitted with a Liberty engine a distance of 633.12 miles in six hours, breaking the record for that time.

How to Prepare for Overseas Service

An Army officer now on foreign duty has written a letter home suggesting a number of things which should be done before embarking and listing the more important items which should be carried along.

His first suggestion is to settle one's business affairs. Following which he remarks that an application should be filed for the Soldiers' and Sailors' Insurance, the study of French begun, and a checking account with an European house established. A code address should also be listed before leaving this country, and all equipment should be carefully and conspicuously marked. A total of 250 lb. may be carried by officers.

In view of the prices of equipment abroad, it is advisable to secure certain things before undertaking a trip overseas. Leather, among other things, is expensive abroad, but, strange to relate, he states that the "Sam Browne" belts are only $6 and $7 in Paris. The best "trench" coats in England and France, however, are reported to cost $35, while whip-cord breeches with doe-skin knees average $6. In general, a dollar in United States money represents 5.70 francs, or 4 shillings, 2 pence. Probably American troops will be paid in French money.

En route, continues the voyageur, caps are convenient, though not worn over there; in fact, only campaign hats and steel helmets are authorized. Pistols are kept much cleaner and safer if boxed for the trip.

A list of the officer's suggestions as to equipment follows: Officers' locker or trunk (wardrobe steamer-trunks are handy), hand-bag, with toilet articles, trench mirror, wrist watch, pocket flash-light, flint, wheel and tinder lighter, canned solidified alcohol, and tobacco for two months, a short winter coat, knee-laced waterproof boots, boot and shoe laces, fleece-lined gloves, extra hat, shoes and mess outfit, plenty of handkerchiefs and socks, a cable code book, coffee (tea is plentiful), chocolate, soup and beef tablets or a few cans of soup, face and laundry soap, a few books, plenty of United States stamps, a good fountain pen, blank forms and stationery and a wash basin.

Lord Northcliffe on Aircraft Production

In an interview Lord Northcliffe says he will return to the United States as head of the British War Mission after the Allied conferences and trip to the fronts.

If the British Government desired, he said that he would devote much of this time to the question of aircraft production in the United States, and added:

"My great fear is that the American output will exceed the possibilities of training officers and mechanics. Americans are willing to make any type of engine we ask, in addition to their own Liberty engine."

Assigned to Joint Technical Board

Col. H. H. Arnold and Maj. Harold S. Martin, Signal Corps, have been appointed members of the Joint Army and Navy Technical Aircraft Board, in place of Brig. Gen. B. D. Foulois and Maj. Henry W. Harms, Signal Corps.

New German Rubber Bomb

Recent dispatches from the fighting front tell of a new rubber-based bouncing bomb recently used by German aviators. The bombs are provided with a resilient base of leather, rubber and rope, which makes them bound upward into the air after striking the ground. The special fuse attached causes the bomb to burst when it has reached the pinnacle of its bound, about six feet in the air.

Butts of these aerial bombs, which have been picked up, show that all are provided with a base of synthetic rubber and are wrapped around and around with rope, making them resilient.

The bombs are weighted so that the end with the rubber pad will strike the ground first. The impact with the earth sets in motion the time fuse, which detonates the bomb a fraction of a second later when the bomb has bounded into the air.

Air Mail for U. S. Troops

Aerial postal service between the American troops in France and their British and French comrades, with an extension to Algeria and Morocco, is planned by the municipal post authorities at Lyons.

A commission has been appointed to study the question of routes and sailing times for the service.

Swear Allegiance at Standard Plants

Men and women employed by the Standard Aero Corp. took the oath of allegiance to the United States recently.

Realizing that the various fires and other destructive acts committed by enemy aliens constitute a deadly peril to this country's war preparations, Harry Bowers Mingle, president of the corporation, first instituted a rigid inquiry into the nationality and antecedents of every one of his thousands of employes, and then ordered that every man and woman of them should take the oath of allegiance. The oath was administered by a public official, legally empowered to do so, to the office force and executives, as well as the factory employes.

The Standard Aero Corp. has just moved a major portion of its help and machinery to the new plant at Elizabeth, N. J.

In addition to the original place which existed at the time the purchase was made of the original property from John Stevenson Car Works, a new two-story aircraft assembly building has been put up, running the full length of the shops; barracks for the men have been built, ready to hold two hundred and fifty men, each separately in a room provided with shower baths, etc.

There is under construction an administration building which will be completed within a month and which will house all office help and contain the principal executive offices, etc. Within a month the immense restaurant and lunch room of the company will be running, where all the employes will be fed from the company's kitchen.

Coincident with the moving of the main portion of the operating forces to Elizabeth, the Standard Aero Corp. has found it necessary to organize an additional company under the name of the Standard Aircraft Corp. under the laws of the State of New York.

On and after Nov. 1, 1917, these two organizations, under practically the same management, but with their enlarged facilities and redoubled energy, will divide their activities as follows:

The Standard Aero Corp. of New York, operating at Elizabeth, will continue as an engineering and experimental organization, doing primarily aircraft engineering and experimental work, while The Standard Aircraft Corp. will be the production or manufacturing company, operating at the Plainfield and Elizabeth plants.

A number of changes in personnel have taken place with the new organization, which are as follows:

Clifford Talbot, formerly superintendent of the New England Westinghouse, has taken charge as works manager of all plants.

E. E. Pennewill, formerly superintendent of the Standard Aero Corp., becomes general manager, and C. V. Bradford, formerly general manager, becomes vice-president.

The headquarters and main offices of the company will be at Elizabeth. The company expects to push to the uttermost its work by employing women help as one of the best means of expediting aircraft production.

Air Minister for Great Britain

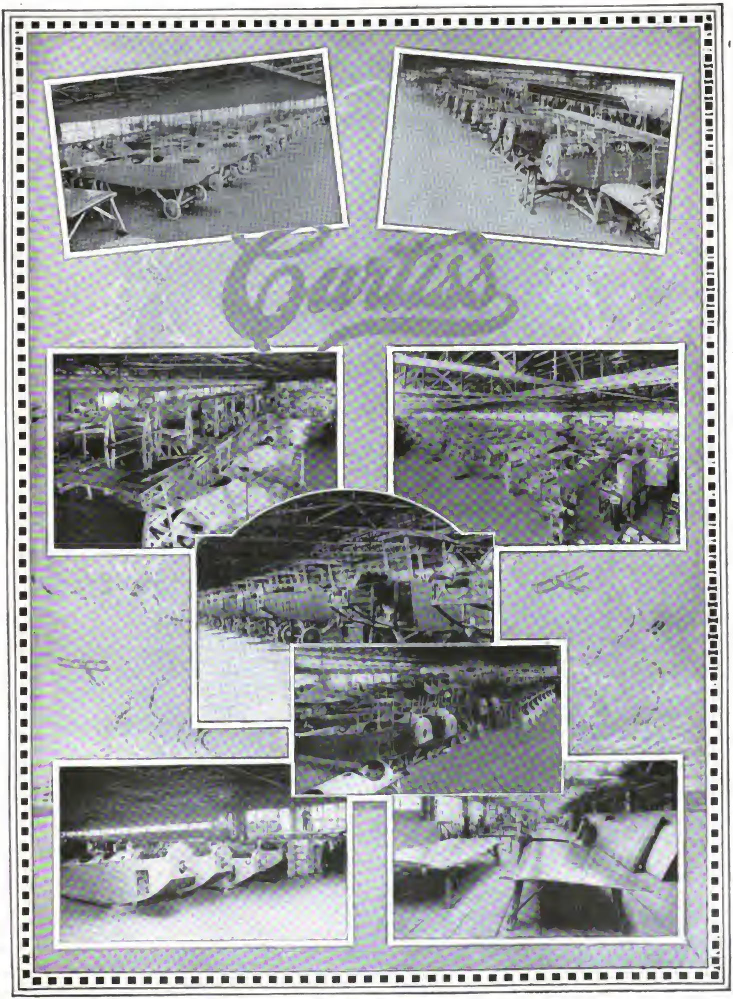
It is reported that a bill for the establishment of an air ministry will be introduced in the British House of Commons in a few days. It will provide for co-ordination in several branches of the work of the naval and military air services and the air board. The ministry will assume complete control of the new arm gradually.

A central organization policy and a central organization supply will be established. This bureau will be given power over discipline and pay. Lord Northcliffe was offered the position of first air minister, but declined. His younger brother, Lord Rothermere, then accepted the post. Lord Rothermere is the chief proprietor of *The Daily Record and Mail* of Glasgow and of the *Leeds Mercury*.

Sweden to England Via the Air

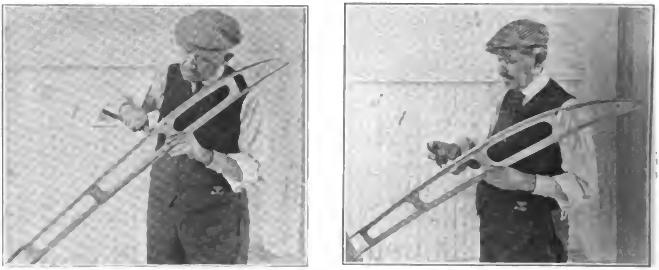
An airship passenger-and-mail service between Sweden, Finland and England has been projected at Stockholm, Sweden, according to a special report received by the Department of Commerce, Washington, D. C.

A Swedish company has been incorporated with a capitalization of $536,000, to organize and operate this line, and it is reported that airships designed to carry six passengers and a large amount of mail are under construction.



The Curtiss Aeroplane Company, Buffalo, N. Y.
America Trans Oceanic Company, 280 Madison Ave., New York City, New York Agent·

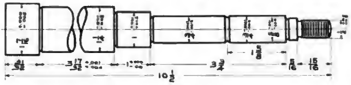
"SOMEWHERE IN THE ROGERS SHOPS" where thousands of wood parts for use in Airplane Construction are handled every day.



Lower Cuts show two methods of Measuring a Wing Rib Cap Strip, the old Two Foot Rule way and the modern Rogers way of Measuring with a Rogers Fig. 13 Double Ended Limit Gauge ground accurate to .0001 of an inch with a tolerance limit of plus or minus 1/64", which is the accuracy called for on this particular job.

Rogers Accuracy Has Been the Foundation of Rogers Success

ROGERS CONSTRUCTION COMPANY, AIRCRAFT PARTS
THE JOHN M. ROGERS WORKS, MEASURING APPLIANCES
GLOUCESTER CITY, NEW JERSEY



Three Times as Many Shafts per Day on the No. 4 Universal Turret Screw Machine

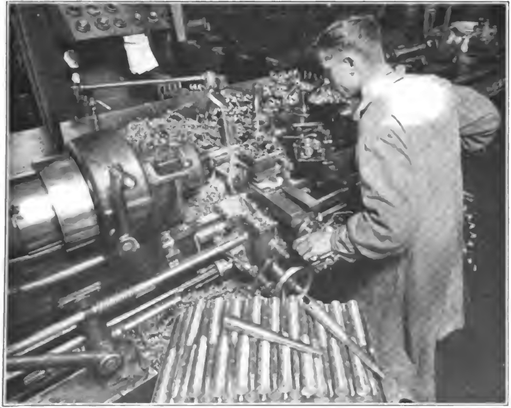
Heretofore the best time recorded for machining this pinion shaft on a turret lathe without a carriage has been 30 minutes each or 20 per day.

But when transferred to the No. 4 with its instantly changeable simultaneous turret-and-carriage operation the time was reduced to 10 minutes each or 60 per day.

Such achievements are common occurrences where any W. & S. machines are in use. On the 3-A Hollow Hexagon Turret Lathe Gnome type engine cylinders—previously a 35-hour job—have been produced in 2 hours and 47 minutes from 47 lb. forgings. Again on the 3-A a 21¾" solenoid plunger previously made on engine lathes at the rate of 2 per day were made in 35 minutes each. On the 2-A a 17⅜" cast iron sleeve—a job they said was impossible on a turret lathe—was made in 30 minutes against its previous time of 2 hours on an engine lathe. Hundreds of other time-saving instances await the inquiry of those interested in meeting emergency demands for record-breaking quick production.

Because of their close working and extraordinary accuracy no less than their unprecedented speed all W. & S. machines are unquestionably the most economical installation for airplane plants.

Inquiries will be promptly answered, by mail or in person, if you will send blueprints with rough and finished samples to our nearest office.



While the ½", ⅝" and ¾" diameters are being turned and threaded by the hexagon turret, the 1", 1¼" and 1-7/16" diameters are being turned by the square turret on the carriage.

THE
WARNER
& SWASEY
COMPANY

CLEVELAND, OHIO,
U. S. A.

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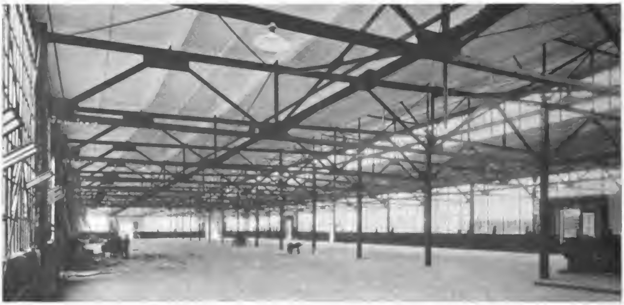
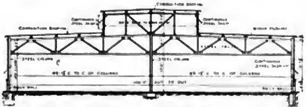


An Austin Standard Factory-Building Built for The General Electric Company at Schenectady, N. Y., in Thirty Working-Days

Austin Standard Factory-Buildings



On April 23, 1917, The General Electric Company ordered as Building 89, 300 linear feet of this Austin Standard No. 3 Building 100 feet wide.

Building No. 89 of The General Electric Company at Schenectady, N. Y., on May 19, 1917, 21 working-days after day of order. The steel is more than half up and the roof is going on.

Exterior of Building 89 of The General Electric Company on May 31, 30 working-days after the order. Finishing this building on time last June brought us orders for five more buildings for the same customer, all of which have been finished *on time or ahead of time*

Can be Occupied in 30 Working-days

YOU can move into a new Austin Standard Factory-Building in thirty working-days from the day you sign an Austin *Thirty-Day Guaranteed-Delivery Contract.*

This is possible because the Austin Company—subject to prior sale—actually has all the materials in stock ready for immediate shipment.

The General Electric Company, The Dayton Metal Products Company, the United States Government, and many others have already taken advantage of Austin 30-day Guaranteed-Delivery of completed floor-space.

You can close the contract for which you are negotiating, buy your machinery for delivery at a given date, and buy your building on the same basis: from a catalog, at a given price, for guaranteed delivery, ready for occupancy in thirty working-days.

Write, phone or wire the office nearest the proposed work.

The Austin Company

INDUSTRIAL BUILDERS
Cleveland, Ohio
New York Philadelphia Pittsburgh Indianapolis
Export Representatives: American Steel Export Co., Woolworth Building, New York

The eyes
of the "eyes" of the Army
must be protected.
If the Goggle you wear is not RESISTAL you take an unnecessary chance. RESISTAL cannot shatter.

On Nov. 23rd, 1917, the Navy Department adopted RESISTAL for aviators' goggles and masks.

Strauss & Buegeleisen
37 Warren Street New York City

In addition to the Army standard frame RESISTAL is now made in a variety of frames for aviators' goggles and masks.

Men of Draft Age Must Enlist Before December 13

The new selective draft regulations prevent any man from 21 to 31 years old enlisting after December 15th. In order to complete your enlistment (be examined, accepted and take the oath), you should positively report to any recruiting officer before December 13th.

The War Will Be Won In The Air

AEROPLANE MOTOR MECHANICS

NOW BEING TAUGHT AT THE MICHIGAN STATE AUTO SCHOOL

A course in Aeronautics has been established, to train mechanicians for the Aviation Service. This will include thorough instruction and practice in building, running, and repairing aeroplane motors, repairing of planes and other parts; lectures in the theory of flying, history of aviation, construction of propellers, fuselage work, including metal fittings, bracing, and wiring, wing construction, controls, landing gear and pontoons and the care of the entire machine.

COMPLETE EQUIPMENT

By special permission, the necessary equipment for thorough instruction has been secured from the Curtiss Aeroplane Company. A Curtiss expert will head the faculty. He is an authority on aero-motors and aeroplanes, as well as hydros and flying boats. He will be assisted by a competent staff of instructors, who have had over eight years of educational training along similar lines.

The Business of the Future

The men who become trained aeroplane motor mechanics now will be big men in the aeroplane business. Only a short time ago the automobile business was starting. The men who got in then are now the Big Men. The aeroplane business is in its infancy. The war will give it a start. The men who train now will be Big Men too. The work is extremely interesting and will grow in interest as the business develops. Aeroplanes and Seaplanes will be used for every purpose. Trained aero-motor mechanics will always be in big demand.

Trained Aero Men Serve Their Country Best

THE CURTISS AEROPLANE CO.
Aeroplanes, Hydroaeroplanes, Flying Boats, Aeronautical Motors.
BUFFALO, U. S. A.

September 17, 1917.

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Michigan State Auto School, Detroit, Mich.

Dear Mr. Zeller:—

In accordance with our conversation I have asked the Sales Department to send you a collection of motor and aeroplane parts which you can use in connection with your aeroplane mechanics' school. You will find, I think, a sufficient number of parts so that you will have no difficulty in explaining to your students the general principles of construction and operation.

These models, together with the literature which you now have will, I believe, furnish a valuable background upon which your new school work can be based. There is going to be a big demand for good aeroplane mechanics and for that reason we believe that your activity along this line is very timely and commendable.

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THE CURTISS AEROPLANE CO.
F. L. Faurote, Advertising Manager.

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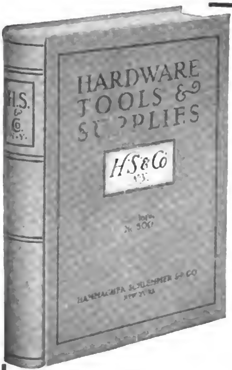

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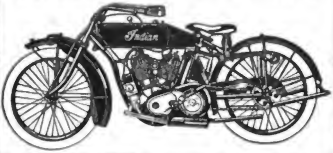

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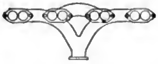

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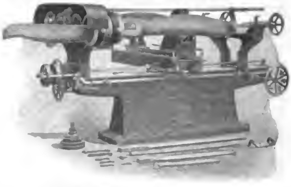

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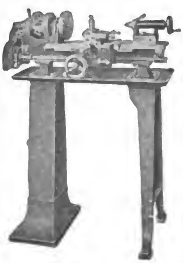

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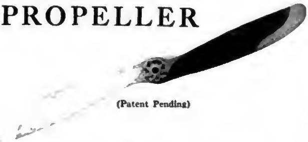

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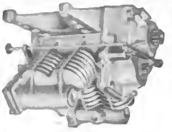
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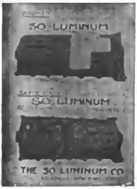

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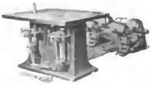
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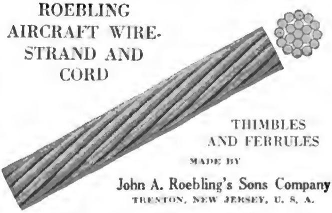

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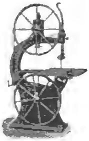

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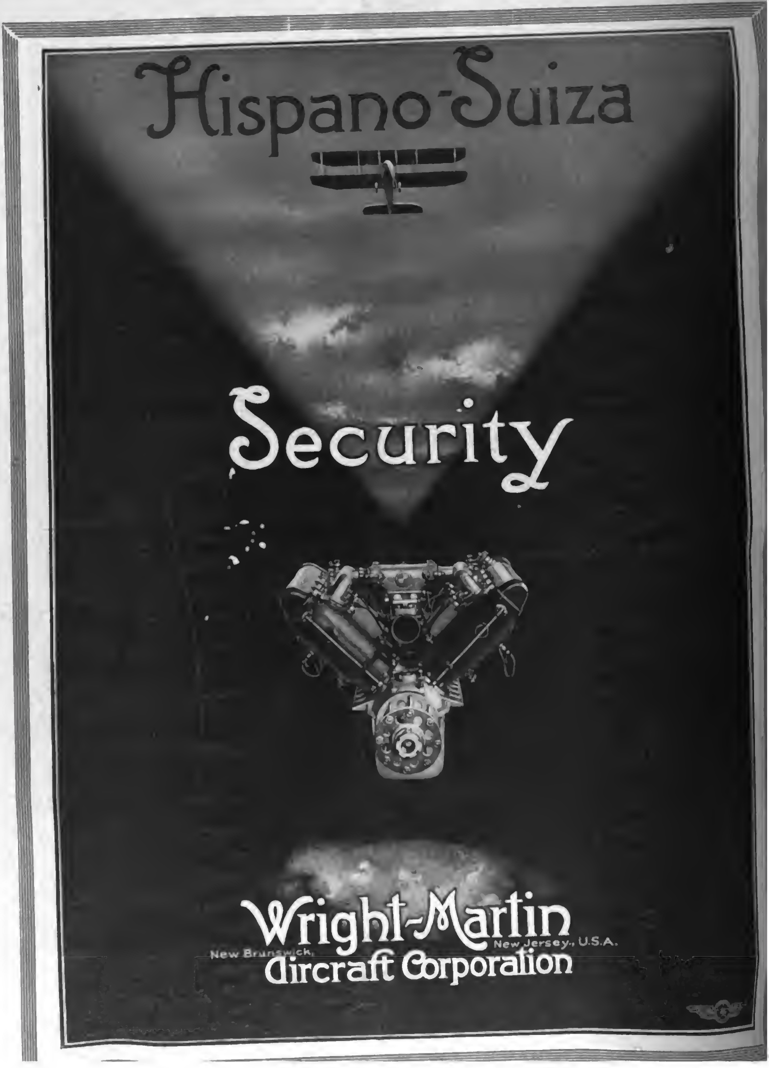

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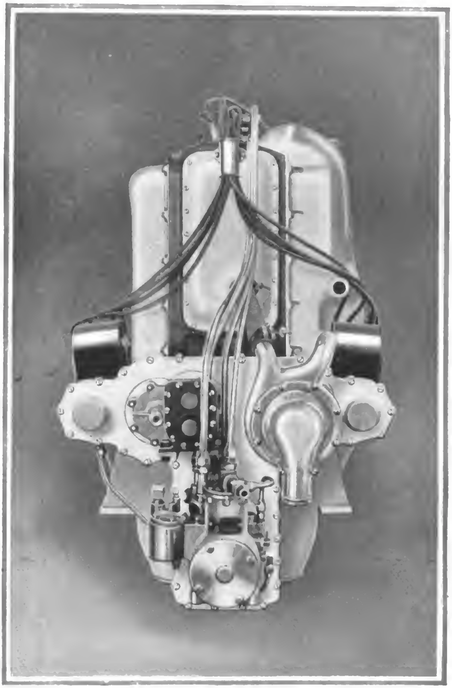

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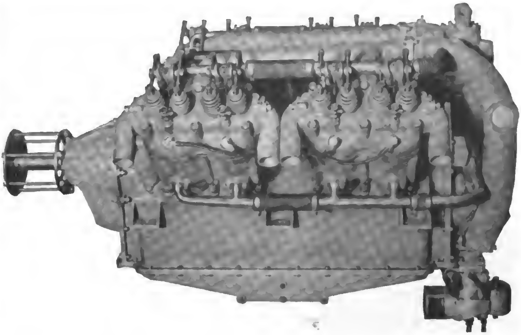

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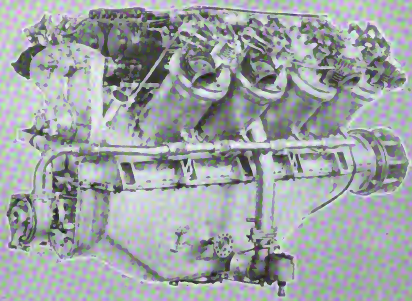

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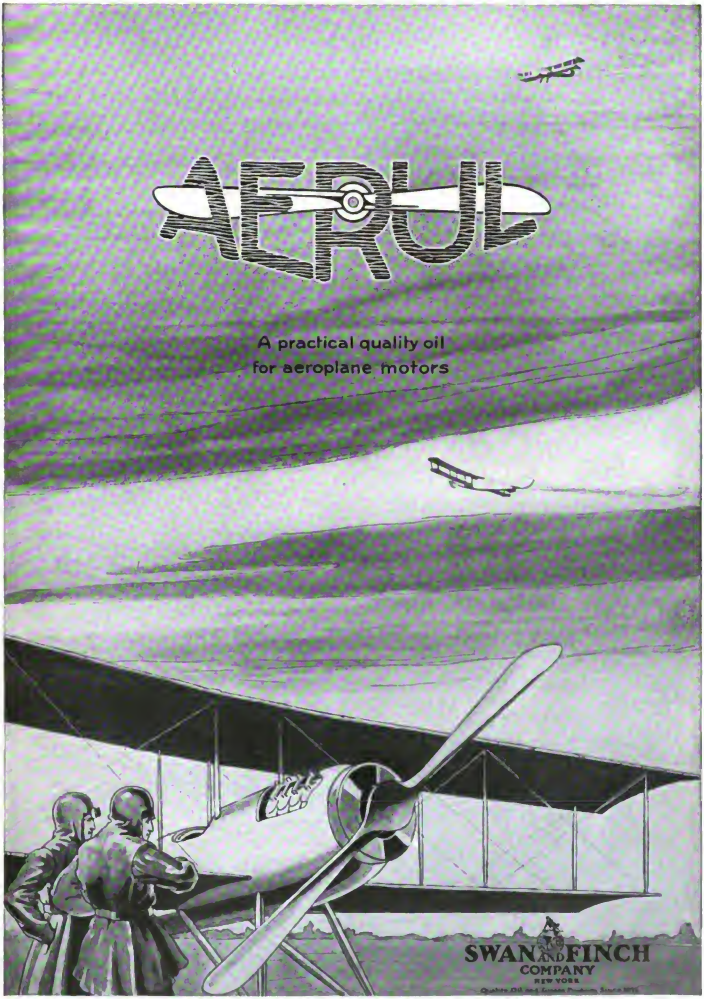
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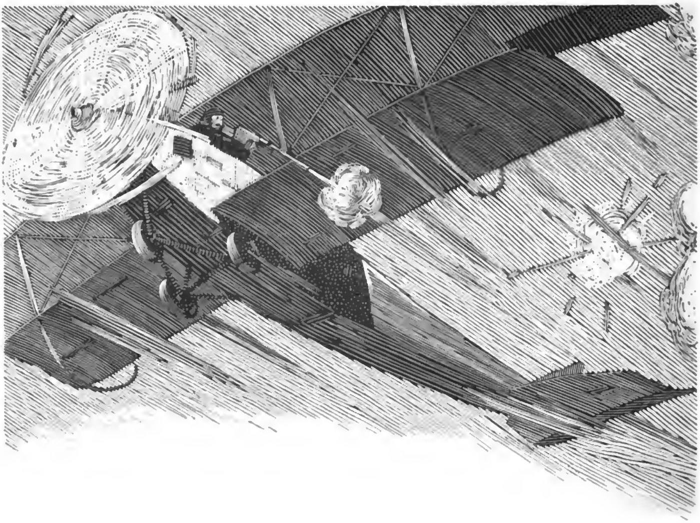

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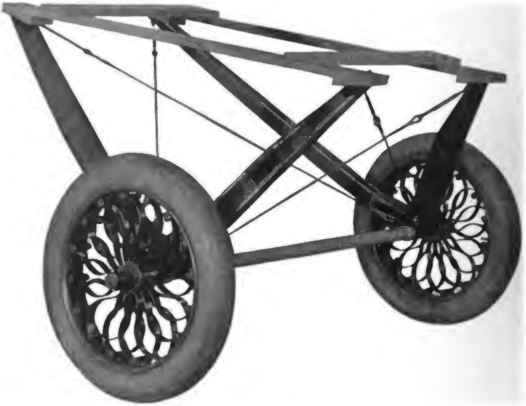

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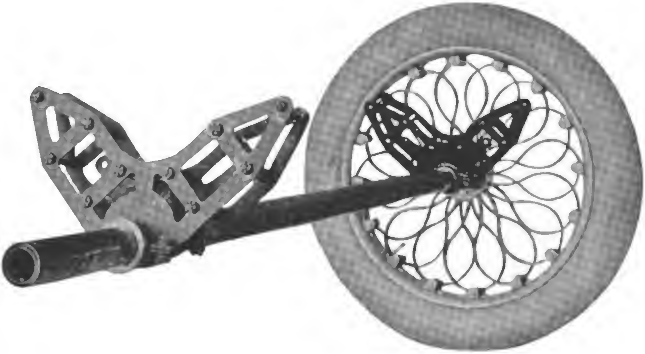

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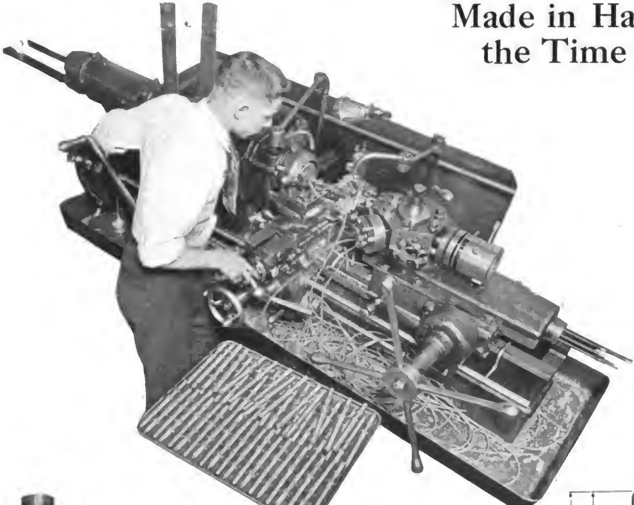

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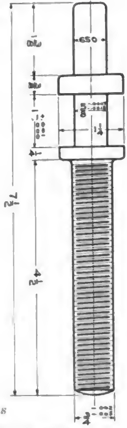

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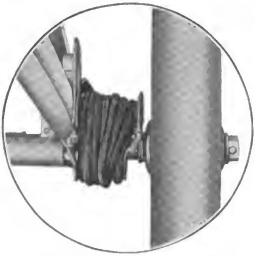

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AVIATION
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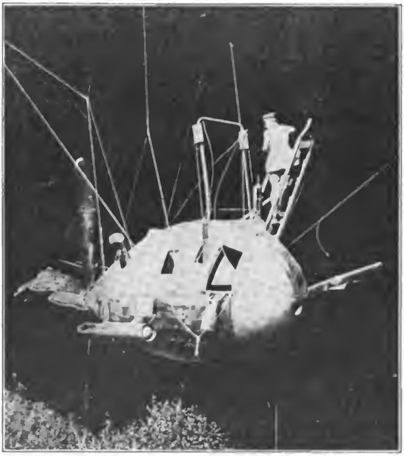
Vol. III | December 15, 1917 | No. 10

The Modern Zeppelin Airship

By Ladislas d'Orcy, M.S.A.E.

The capture, by French aviators, of the German naval airship L-49 on Oct. 20, at Bourbonne-les-Bains, has lifted the veil of secrecy which surrounded the constructional details of Zeppelin airships since the outbreak of the war. The L-33, which was brought down by British aviators a year ago in Essex, already gave certain indications of the improvements embodied during three years of warfare, but as the vessel was burned by its crew these indications were necessarily incomplete. The complete state of preservation of the L-49 now, happily, supplements our knowledge of the latest German practice in rigid airship construction, for, although this airship is a greatly perfected L-33, both vessels may be regarded as belonging to virtually the same, so-called super-Zeppelin class.

General Considerations.—The most striking points in the new Zeppelin model are its dimensions, its shape, and the arrangement of the propelling apparatus. The overall length has grown from 158 m., of the *ante-bellum* airship L-3, to 196 m. on the L-49; the master diameter has increased, in a much greater proportion, from 16.60 m. to 25 m., with the result that the fineness ratio has gone back from 9.5 to 7.8. This leads us at once to consider the stream-line of the new ships. The cross-section is now a 25-sided polygon, instead of a 17-sided one, thus approaching the ideal circular cross-section; the nose is much blunter than heretofore, while the stern tapers to a distinctly conical end. This shape, taken in conjunction with the decreased fineness ratio, insures a better flow of the air filaments along the hull and greatly reduces frictional resistance. This is also cut down materially in so far as the keel is now built into the hull instead of protruding therefrom, while the cars are carefully stream-lined and only carry pusher airscrews. The elaborate staying of airscrews by means of outriggers on either side of the hull, which in part still survived on the L-33, is thus dispensed with. Finally, the steering-gear is of simple, cruciform design, consisting of symmetrically shaped horizontal and vertical fins and rudders, instead of the high resistance multiplane control surfaces of early Zeppelins. All of this obviously results in a material saving of head resistance; in other words, greater speed can be attained with equal motive power. Such are, briefly, the most striking external improvements found on the super-Zeppelin. Internally, the Zeppelin has surely been improved as much as externally; the constructional details involved in the internal arrangement, which are not, generally, visible in the accompanying illustrations, will for this reason now be discussed at some length.



Starboard Power Car of the L-49. Note Radiator Hoist for Varying Area of Cooling Surface
(C) *Underwood & Underwood*

The Hull.—The hull is built up, as heretofore, of duralumin lattice girders of triangular cross-section, there being twenty-five longitudinals and thirty-six polygonals, not counting minor fairing elements occurring at the nose and at the stern. These girders are built up of three corner rails of channel section, which are inter-connected by X-pieces of fluted section; the cross-section of the girders is an isoceles triangle measuring 0.27 m. in height and 0.14 m. at the base. The thickness of the metal varies from 0.5 to 1.0 mm., according to the strength required by the function; the strongest girders weigh approximately 1 kg. per meter length, and have a tensile strength estimated at from 38 to 40 kg. per sq. mm.

The joining of longitudinals and polygonals, which intersect one another at right angles, is rather difficult to explain, in writing, with sufficient clearness. For a clear comprehension it should be noted before all that while the cross-section of the hull is a twenty-five-sided polygon, one half of the longitudinals serve but as fairing elements, so that the *structure de force* of the hull is actually a thirteen-sided polygon. There are then thirteen main longitudinals, which run at the angles of the transverse girders forming the main polygons, while intermediate longitudinals are carried in the middle of and upon the outer side of the transverse girders. The bottom side of the main polygon does not, however, carry an intermediate longitudinal, this in order not to weaken the keel, which occurs at this place. Every second transverse girder is internally braced up by a king post truss, an extension of which is carried through the girder and serves as a head for the intermediate longitudinals.

The keel, which now runs within the hull, is formed, as has been said before, of two main longitudinals, forming its base, and of an additional internal longitudinal, situated 3 m. above and in the center line of the base, thus forming in cross-section the letter A. This triangular structure is stiffened transversely by cross members corresponding to the cross-bar of the letter A, and longitudinally by longitudinal girders occurring at the height of the cross bars. The apex of the keel is furthermore joined to the transverse girders of the hull by horizontal girders, of which there appear, however, to be only a limited number. The internal longitudinal which forms the apex of the keel is not carried through the whole length of the ship, but apparently stops in the neighborhood of the forward and after cars. Nor are the main and intermediate longitudinals carried through, for all stop at the first and last polygonal girders; at the nose only the apex rail of the longitudinals continues beyond the first transverse frame, the rails meeting in a nose ring. Here again the principle of the *structure de force* is emphasized in that the outer rails of the main longitudinals run through to the extreme end of the hull, whereas those of the intermediate girders stop further inward. The construction of the stern is similar to that of the nose.

Nose of the L-49. A Gas Valve is Visible on the Upper Right-Hand Side
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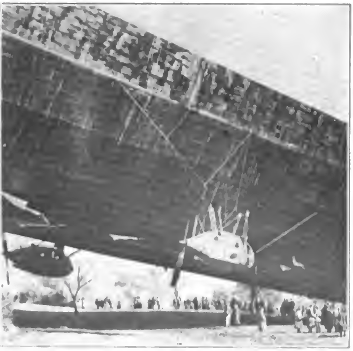

Midship Section of the L-49, Showing Relative Position of Power Cars
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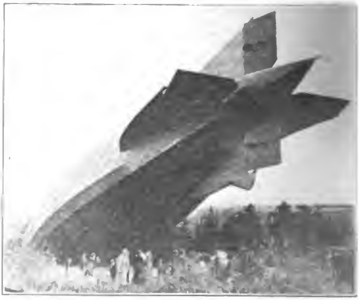
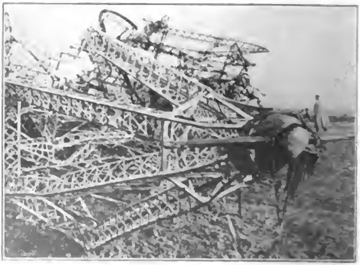
The control surfaces are duralumin frames, which are built up in a way similar to the hull girders, except that their cross-section is rectangular and has much smaller proportions. Rudders and elevators are balanced at about one-third chord length from the leading edge, to facilitate manual control. The careful streamlining of these airships extends to the very control arms of the mobile surfaces, which are quadrant shaped. The control cable runs in a groove provided on the periphery of the quadrants. The lower vertical fin is protected by a streamlined skid.



Stern View of the L-49
Photo Pictorial Press

The truss of the hull is of the conventional type, the panels formed by the intersection of longitudinals and transverse girders being braced by diagonal stays, while the athwartship truss consists mainly of radial wires running from the angles of the main polygons to a central hub. There appears to be, in addition, a special truss which transmits the weight of the keel to some of the upper longitudinals, that is, to the region of maximum lift.

The outer cover of the hull is made of linen fabric, which on the lower half is dyed a brilliant black by means of a coal-tar dope, while the upper half is painted cloud gray. This camouflage answers the purpose of misleading aviators who may be at a higher level than the airship, while any detection from the ground is rendered very difficult at night, since the black underside does not reflect the rays of searchlights. The last, "invisible," raid on London seems to bear out the worth of this color scheme. The outer cover is laced in sections onto the framework, an arrangement which facilitates inspection of the gas cells when the airship is berthed in its shed.



Girder Work of the Stern of the L-44; in the Background, an Elevator Frame
Photo Pictorial Press

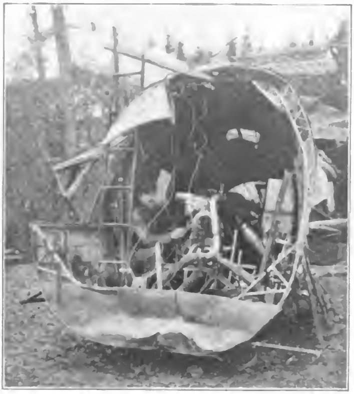
The Forward Car of the L-49, Being Taken Down by French Sappers
(C) Underwood & Underwood

The Gas Bags.—The gas bags, numbering nineteen on the L-33 and eighteen on the L-49, are made of cotton fabric internally lined with goldbeaters' skin, and not, as prior to the war, of rubberized fabric. The use of goldbeaters' skin, which some writers mistakenly attribute to Germany's rubber shortage, affords much greater gas tightness (one-fifth of one per cent. in twenty-four hours, as against one-half to one per cent. for rubberized fabric); and while its high cost is irrelevant in time of war, its only real drawback is low tensile strength, which prevents the gas from being stored at anything above atmospheric pressure. The reinforcement of this material by cotton fabric is, therefore, a considerable improvement over *ante-bellum* practice, and explains why the Germans have been able to provide some of the gas bags of the L-49 with a compensating ballonnet.

Front Compartment of the Forward Car After Its Separation from the Rear Compartment
(C) Underwood & Underwood

Engine Compartment of the Forward Car
(C) Underwood & Underwood

Although in a rigid airship the shape of the hull is not dependent upon internal pressure, the use of the ballonnet may have several advantages. Thus, when the gas bags are not taut, the ballonnet permits to compress the gas so it will apply its lift upon the upper portion of the hull instead of surging about and displacing the center of buoyancy, which naturally alters the trim. On the other hand, by keeping the gas bags taut, the danger of self-electrification is lessened to a great extent, for rubberized fabric emits sparks when it is creased in any way. This danger is not to be feared with goldbeaters' skin. Finally, losses of gas due to variations of atmospheric pressure and temperature are greatly lessened with the use of the new Zeppelin fabric, because if the gas bags are filled at sea level at the atmospheric pressure, the gas may be permitted to expand, upon reaching higher regions, up to the safety factor of the fabric before being expelled by the automatic valves.



Close View of the Engine Installation
(C) Underwood & Underwood

Forward Car of the L-49, Exhibited at Napoleon's Tomb
(C) Kadel & Herbert

A strong but light ramie netting, which is trussed to the framework, surrounds each gas bag and prevents it from either chafing against the hull or bulging into the keel. The gas bags are roughly drum-shaped, except for a portion which is cut out at the bottom to furnish sufficient clearance for the keel.

Each gas bag is provided with a spring loaded safety valve, which opens into a vertical, ventilating shaft running to the top of the hull. Each two adjoining gas bags have a common ventilating shaft, consisting of a wire armature; this is why the radial truss occurs only at every second transverse girder. The forward and after gas bags have in addition to the safety valve a maneuver valve, which is lacking in the gas bags of the midship portion, in order not to decrease the lift where it is most needed.

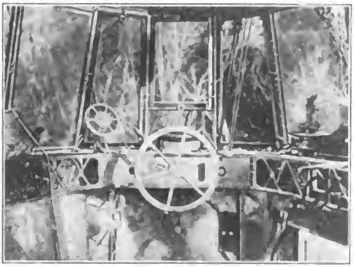
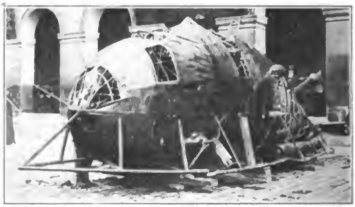


Chart Room of the L-49. Note Bomb Sight on the Right
Photo Central News Photo Service

The Cars.—The L-33, as well as the L-49, each had four cars, mounted crosswise in such fashion that the forward and after cars were situated in the centerline of the ship, while the two remaining cars were mounted about amidships, on a common transverse axis, on either side of the hull. The midship cars serve exclusively as engine rooms, each housing a 240 hp. Maybach engine, which drives through a clutch and speed-change transmission a pusher screw of 5 m. diameter. The power plant of the forward car is identical, while that of the after car consists of two Maybach engines, which may be coupled to a single pusher screw either separately or simultaneously, according to needs of speeding up or slowing down.

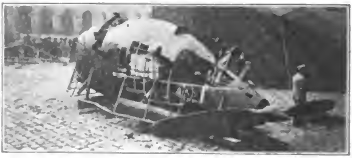
Elevator Wheel in the Chart Room
(C) Underwood & Underwood

The forward car is subdivided into a chart room and an engine room, which are structurally separate parts, being united only by an outer casing of fabric. This structural separation is due to the necessity of preventing the vibrations of the engine being transmitted to the radio cabin, which is situated in the after part of the chart room. The latter is very spacious, measuring 6 m. in length, 2.50 m. in height and 2.25 m. in width; the engine room is 4.50 m. long. The chart room is provided with large mica bay windows, and contains all the control gears, such as rudder and elevator wheels, valve and ballast lines, engine telegraphs, gas pressure and temperature indicators, as well as the usual navigating instruments. The bomb sight and the electric bomb release mechanism are also located in the chart room.



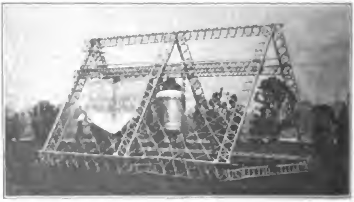
Front View of a Power Car
(C) Kadel & Herbert

The cars are built up of a light duralumin framework, which is covered on the lower half with corrugated sheet aluminum, while the upper half is covered with fireproofed fabric. They are connected to the hull by means of hollow wooden struts and cables.



Rear View of a Power Car. In the Background a King-post Girder
(C) Kadel & Herbert

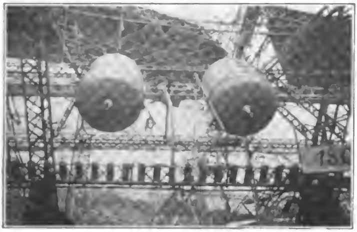
Internal Equipment.—The four cars are connected with one another by means of a narrow gangway running in the middle of the keel, from which access is afforded to the cars by suitable ladders. The observation platform which is provided atop of the hull can also be reached from the keel; for this purpose a climbing tube, consisting of a wire armature covered with fabric, and containing an aluminum ladder, is fitted amidships between two gas bags. An additional lookout post, situated at the stern, aft of the rudders, is reached in the same way. These platforms were devoid of any armament on the L-49; the L-33, however, mounted two Maxims forward and



Portion of the Keel, with a Fuel Tank and a Ballast Bag Hung from the Rack Rail
(C) Kadel & Herbert

one aft, and had, in addition, six machine rifles mounted on the cars.

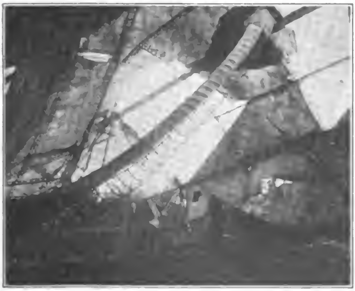
All the mobile weights of the Zeppelin, such as fuel tanks, water ballast bags and bombs, are distributed in the keel. All of these were suspended, in the L-49, on the longitudinal girders running at the height of the cross members, above referred to. The fuel tanks are aluminum cylinders of 300 liters capacity, while the water ballast is carried in bags of 1,000 liters capacity, hand lines, leading to the chart room, controlling the release valves. To prevent freezing, the water ballast is mixed with alcohol. A noteworthy feature of the L-49 was the liberal use of trap doors through which all mobile weights may be dropped in case of emergency, each gasoline tank, ballast bag and bomb being provided with its individual trap door. No electric wiring is found in the keel except that required by the bomb gear, all internal lighting being insured by radium compound knobs. All inscriptions relative to gas bags, fuel tanks, etc., are similarly indicated by night. On either side of the gangway hammocks are suspended for the crew.



THE GANGWAY AS SEEN FROM BELOW. NOTE NETTING OVER THE KEEL

(C) *Underwood & Underwood*

Apportionment of Weights.—Although detailed information from abroad is still lacking, the weight of sufficient items is known, so one may figure out with tolerable accuracy how the weights were apportioned in the L-49. The weight per meter length of the girders forming the hull proper being 1 kg., and the length of the vessel being approximately 200 m., twenty-five longitudinals will weigh about 5 tons. Thirty-six transverse girders of about 80 m. circumference weigh roughly 3 tons. The total area of the outer cover is estimated at 10,000 sq. m., which, at 200 g. per sq. m. of fabric (such as used in the outer cover of early Zeppelins) puts the weight of the outer cover at 2.6 tons. A similar computation for the goldbeaters' skin of the gas bags, of which there are about 20,000 sq m. in all, and which weighs 170 g. per sq. m. (according to German pre-war figures) places the total weight of the gas bags at 3.4 tons. The forward and after cars weigh 2 tons each, the midship cars 1 ton each. If a further allowance of 2 tons be made for the weight of the internal girderwork and the truss, it would seem that the present estimate of weights should not miss the mark very widely. It is obvious, that in discussing a machine from a 3,000 mile distance, many minor items are likely to escape one's attention; therefore, the writer desires to emphasize that this apportionment can only be approximately correct.



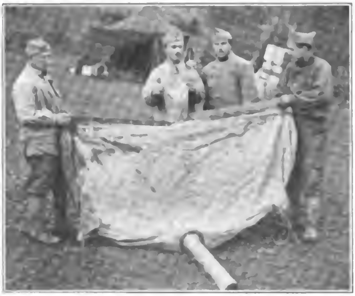
CLIMBING TUBE, LEADING TO THE AFTER PLATFORM ON TOP OF THE HULL

(C) *Underwood & Underwood*

THE ELEVATORS OF THE L-49

(C) *Underwood & Underwood*

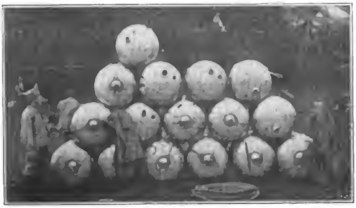
From the foregoing the gross weight of the L-49, which had a volume of 55,000 cu. m., appears to be 22 tons. The total lift furnished by 55,000 cu. m. of hydrogen at sea level being about 60 tons, 38 tons remain available as useful load. This figure may appear excessive, for prior to the war the useful load of Zeppelins amounted to about 30 per cent. the total lift, while even non-rigid airships have not, as yet, exceeded 50 per cent. Yet, when it is realized that an airship loses 1 per cent. of its lift per 100 m. ascent, and that the barograph of the L-45 (another Zeppelin brought down in France) recorded an attained level of 6,200 m., it is not difficult to guess to what use the greater portion of the Zeppelin's useful load is put.



WATER BALLAST BAG, COMPLETE WITH ITS FILLING APPENDIX AND RELEASE VALVE

(C) *Underwood & Underwood*

To reach a level of 6,000 m. a 60-ton Zeppelin must lighten itself of 60 per cent. of its weight; its total weight will then amount to only 24 tons, that is 2 tons in excess of its gross weight. But in climbing to that level the Zeppelin has to carry in addition to its crew of 19, who represent a weight of 1½ tons, a sufficient fuel supply as well as a certain amount of ballast required for compensating sudden variations of lift. This would obviously be an impossible achievement were the Zeppelin not endowed with dynamic lift. No precise figures exist on this item, though one might estimate its value, for a 60-ton vessel, as being of 6 or 7 tons.



THE FUEL TANKS OF THE L-49
(C) Underwood & Underwood

The apportionment of the useful load might then be the following:

Fuel for 24 hours	7	tons
Bombs	2	tons
Crew of nineteen	1½	tons
Accessories	1½	tons
Ballast	26	tons
Useful load	38	tons

Even with this stupendous amount of water ballast a 60-ton Zeppelin can reach the 6,000 m. level only after it has expended all of its bombs and a considerable amount of its fuel supply, always making allowance for the supplementary lift afforded by dynamic reaction. These considerations furnish conclusive evidence of the tremendous task which confronted the French aviators and anti-aircraft gunners who defeated Germany's aerial armada. It is obvious that the Zeppelins can keep at a much higher level on the homeward run than when outward bound, as by that time they have dropped their bombs and have expended a great amount of fuel. As a matter of fact several of the enemy raiders were engaged by the French defense forces at great altitude; thus the L-44 was shot down by anti-aircraft guns from a height of 5,500 m., while the L-49 was engaged by four French airplanes at the 5,300 m. level.

It is true, on the other hand, that once the Zeppelin has reached its ceiling it cannot climb again to this level after it has descended to lower altitudes. This is due to the fact that ballast must be thrown not only in the ascent to compensate for the loss of lift due to expansion of hydrogen, but also in the descent when the contracted gas furnishes insufficient lift at the increased atmospheric pressure. The forced landing of the L-45, the L-50 and another Zeppelin, in France, must in part be attributed to these causes.

When the ground is out of sight Zeppelins steer by radio telegraphy, that is, their position is determined from two widely separated land stations by the direction from which each airship's messages are received. During the last raid the radio directives appear to have gone astray or else arrived in undecipherable shape, for according to prisoners' statements the raiders lost their bearings soon after reaching the English coast. On the return trip the low lying fog prevented the Zeppelins from noticing a strong north wind which was blowing at the high level at a speed estimated at 50 miles per hour; the airships thus drifted out of their course unawares and found themselves upon descending over what the pilots believed to be Holland, but which was really France.

THE RADIO SET OF THE L-49
(C) Underwood & Underwood

Examination of the remains of the L-44, which was shot down in flames at Saint-Clément, revealed the interesting fact that this airship did not belong to the super-Zeppelin class, as did the L-45, L-49 and L-50. The L-44 had the following characteristics: Length, 177 m.; diameter, 20 m.; volume, 30,000 cu. m.; four 200 hp. Mercedes engines; radius of action, 800 km.; ceiling, 6,000 m.; explosive load, 1,500 kg.; defensive armament, four machine guns on the cars, and two on the upper platform, amidships.

The Use of Steel in Airplane Construction

By J. M. Rogers, M.E.

The growing scarcity of the woods used in airplane construction gives rise to the consideration of other materials suitable for this purpose. In this discussion, the use of steel will be investigated and an effort will be made to remove the prejudices existing against the use of this material. In addition, the types of steel best suited for airplane construction will be taken up.

That many advantages are to be gained by replacing with steel parts of the airplane structure usually made of wood is evident from the following comparisons. In making these comparisons the following properties will be assumed:

	Tensile Strength, lb/sq. in.	Compressive Strength, lb/sq. in.	Modulus of Elasticity, lb/sq. in.	Weight lb/cu. ft.
Spruce	10,000	5,000	1,300,000	260
Ash	16,000	6,000	1,500,000	4
Steel	....	....	30,000,000	489.

Comparing the moduli of elasticity of these materials, weight for weight, steel has a modulus of 1.23 times that of spruce and 1.63 times that of ash. It is therefore evident that struts of large slenderness ratio, to which Euler's formula applies, can be made lighter of steel than of wood, providing the same outer dimensions of section are maintained.

Steel, to compare favorably, weight for weight, with spruce and ash in direct compression, would have to have compressive strengths of 73,000 and 94,000 lb. per sq. in., respectively.

It will be shown later that these strength values can be greatly exceeded with little difficulty. Furthermore, since a steel strut would naturally be of hollow section, the material would be distributed to better advantage than in a wooden strut of solid section. Therefore, a steel strut will have a radius of gyration greater than that of a wooden strut of the same length and same outer dimensions of section.

It is evident from the above that there would be a distinct advantage in making all compression members of steel.

To compare steel favorably, weight for weight, with ash and spruce, in tension, the steels would have to have tensile strengths of 195,000 and 187,000 lb. per sq. in., respectively.

It will later be shown that these strength values can be appreciably exceeded by the employment of heat-treated, special steels, but there would be a number of difficulties to overcome before they could be used to advantage. It would be necessary to have these steels in a thoroughly annealed condition during the process of working to shape, punching rivet holes, etc., and the finished members would have to be heat-treated.

These members would often be made from thin sheet steel and the process of heat-treating would be very difficult, as there would be considerable danger of the steel warping or being injured in handling. The size and shape of the members might also cause difficulty in heat-treating. There is, however, no reason why most of these obstacles cannot be overcome by careful design and refinement of methods of working.

Steel ought not to vary more than plus or minus ten per cent from its average strength value, but a variation of plus or minus forty per cent in the strength of wood is not at all unusual. It is therefore evident that if steel construction were employed, lower factors of safety could be adopted than are specified at present.

Most of the difficulty that has been encountered in steel construction has been due to the employment of unsatisfactory methods of connecting the structural members. Brazing and welding have been used almost exclusively for this purpose, since they were the easiest methods to employ, but a great deal of trouble has resulted from their adoption.

In brazing and welding the quality of the steel is greatly impaired by the necessity of heating, and in the case of heat-treated steels, the effect of the heat-treating is destroyed. If brazing is carefully done, overheating may be avoided, but brazed connections often fail in service when highly stressed or when subjected to vibratory stresses.

In welding, the steel is necessarily severely overheated and its quality is greatly impaired. Welds may be refined by heat-treating, but often, due to the bulk of certain structural members that have been welded together, it is impossible to heat-treat them.

Refining is possible by the application of an oxy-acetylene torch, but this method is unsatisfactory since it requires a very skilled workman who can judge, by color, the proper refining temperatures. Even though this method of refining is properly carried out, the effects of any previous heat-treatment will be destroyed and the material will be thoroughly annealed.

As the steels used in airplane construction are usually very thin, it is obvious that serious overheating in brazing or welding is certain to occur occasionally, and there will always be an element of doubt in regard to the efficiency of a brazed or welded connection.

It is evident from the above discussion that riveting is the only satisfactory and positive method of connecting structural members, and there is no reason why satisfactory riveted connections cannot be developed.

There seems to be a tendency among most designers and manufacturers of airplanes to use wood in preference to steel, if possible, and where it is necessary to use steel, extremely ductile steels of low tensile strength are usually employed. The arguments usually given against the use of steel and particularly against the use of heat-treated special steels are that there is danger of failure under the shocks to which the members are subjected and that vibration will cause the steel to "crystallize." These arguments are absurd and absolutely without foundation.

Ductility is possibly essential in steel members which are subject to shocks, since the elastic resilience of the material is often not great enough to absorb them, and the material will be stressed beyond its elastic limit, absorbing the shocks by taking on slight permanent deformation.

In motor cars, locomotives, etc., the structural members are sometimes subjected to severe shocks and it is essential that these members be ductile, but if we analyze the nature of the stresses that come upon the structure of an airplane we shall find that they are of an entirely different nature. In flight, an airplane is subjected to no shocks whatsoever, but in landing the landing gear and some of the body members are subjected to shocks, but these, however, are usually not severe.

Since ductility is always obtained at a sacrifice of strength, excessive ductility of steel members is undesirable, and it is evident that all metal fittings and structural members, with the exception of a few body members and the landing gear, should be made of steels of great strength with a low ductility. In fact, but a small amount of ductility is necessary in the landing gear.

A well-known type of airplane, several hundred of which are now in service, is equipped with an axle of heat-treated 3½ per cent nickel steel tubing having a tensile strength in excess of 200,000 lbs. per square inch, an elongation of not more than twelve per cent and a reduction of area of not more than fifty per cent. Not one of these axles, in a period of over a year, has broken. This gives a good idea of the small amount of ductility required in those parts of an airplane which are subjected to the most severe shocks.

A very thorough investigation of the fatigue failure of materials was made by Prof. G. B. Upton of Cornell University, and a great deal of valuable information has been derived from his researches. He succeeded in proving conclusively that the fatigue failure of a material is the direct result of a gradual breaking down of the crystalline structure under the repeated loads to which it is subjected.

It was also determined that the crystalline structure of materials is fully as fine after it has failed in fatigue as it was before the test. In fact, the structure is finer, since numerous crystals have been sheared by the repeated application of load.

The theory that metals will crystallize under repeated or vibratory loading has been advanced to explain the failure of materials that were, due to improper treatment in the process of manufacture, coarsely crystalline to begin with. Furthermore, it is unreasonable to believe that vibration or repeated loads could possibly cause a large number of fine crystals to recrystallize into a small number of large crystals.

A very definite relation was found to exist between the number of applications of stress necessary to cause fatigue failure and the range of the stress. When plotted to logarithmic scale a straight line relation is found to exist between these two variables. It has been determined from a large number of tests that the number of applications of stress necessary to cause a fatigue failure of steel is roughly inversely proportional to the fifth power of the stress range.

The nature of the stresses to which an airplane is subjected are such that fatigue failure of the structural members is quite impossible. The following example will serve to prove this statement:

A particular piece of chrome-vanadium steel having an ultimate tensile strength of 190,000 lb. per sq. in. was found to withstand 250,000 applications of load when the stress range was 90,000 lb. per sq. in. It is therefore evident that the range of stress due to vibration is so small that it could not possibly cause a fatigue failure. A reasonably large stress range is possible in pulling out of dives, banking, encountering gusts, etc., but the frequency of these stresses is never great enough to cause fatigue failure.

Great care must be taken in the design and manufacture of metal fittings to avoid sharp corners, cracks and injury of the material. Large localized stresses are very often developed at sharp corners and frequently they result in failure of the material in service. In this particular type of fatigue failure, the localized stresses are so great that only a small number of applications of stress are necessary to cause failure.

The following data show some remarkable physical properties that were obtained by carefully heat-treating several typical special steels:

CHEMICAL COMPOSITION

No. of Steel	C	Mn	P	S	Ni	Cr	
1	.36	.79	.025	017	3.41	..	..
2	.33	46	.018	.018	3.21	1.05	..
3	51	83	.016	.028	39	1.05	.11

HEAT TREATMENT

No. of Steel	Quench in Oil	Draw
1	1475 deg. Fahr.	500 deg. Fahr.
2	1450 deg. Fahr.	600 deg. Fahr.
3	1550 deg. Fahr.	800 deg. Fahr.

PHYSICAL PROPERTIES

No. of Steel	Ultimate Strength, lb sq. in.	Elongation	of Area Reduction
1	260,000	13 per cent	44 per cent
2	255,000	12 per cent	48 per cent
3	220,000	12 per cent	54 per cent

In conclusion it may be said that the possibilities of steel in the construction of airplanes are very great, but the use of mild steels and the practice of welding and brazing must be largely discontinued if it is desired to make steel construction really successful.

The Austro-Hungarian Seaplanes K.301 and A.25

The Information Section of the Air Division furnishes the following description of two Austro-Hungarian seaplanes which have recently fallen into the hands of the Italian Air Service.

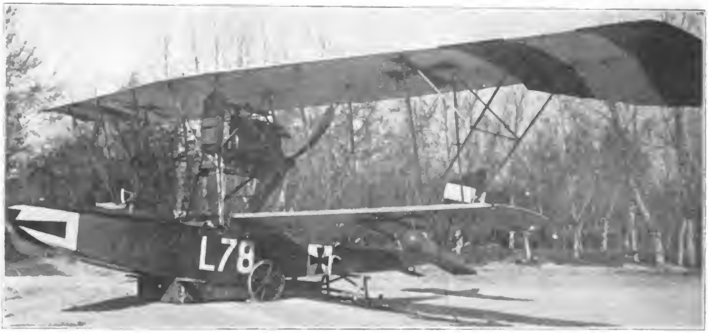
The Three-Seater Seaplane K.301

This machine was brought down by Italian aviators in the night of Jan. 12, 1917, and has proved a highly interesting specimen of Austrian seaplane construction, both because of its intrinsic qualities and because of the recent date at which it was captured.

The seaplane K.301 is a single-pusher, biplane flying boat which resembles in its general lines the well known Lohner type, although it is somewhat larger than the standard seaplane of the latter firm.

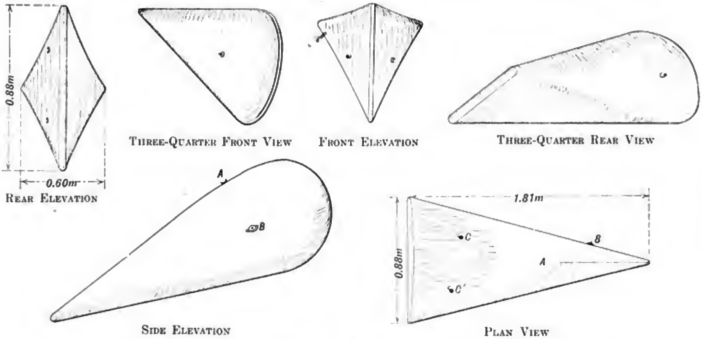
Like the Löhner, the K.301 has the wings set at a pronounced retreat and the ailerons, upper only, are of trapezoidal shape. The span of the upper planes is 9.70 m., that of the lower planes, 7.20 m. The chord is 2.70 m. on the upper planes, and 2.20 m. on the lower planes. The ailerons are 3.47 m. long and 0.90 m. wide.

The planes are connected with one another on either side of the center section by three pairs of steel struts, each pair being braced in the longitudinal axis by steel tubes of 40 mm. outside diameter. The struts of each pair are spaced 120 m. (longitudinally), while the strut pairs are spaced 2.17 m. (transversely).



Central News Photo Service AUSTRIAN LÖHNER FLYING BOAT CAPTURED BY THE ITALIANS *British Official Press Bureau*

The tail group consists of an empennage 4.74 m. long and 1.27 m. wide, and of an elevator 4.74 m. long and 0.87 m. wide. Contrary to Löhner practice, the rudder is of the balanced type.



REAR ELEVATION

THREE-QUARTER FRONT VIEW

FRONT ELEVATION

THREE-QUARTER REAR VIEW

SIDE ELEVATION

PLAN VIEW

DETAILS OF A WING PONTOON OF THE K. 301

The hull is of the general Löhner type and is fitted with two cockpits in tandem fashion. The forward cockpit is provided with a seat for the gunner and mounts a machine gun on a revolving turret which is armored, like on Austrian machines of an older type. In the after cockpit two seats are provided side by side for the pilot and the observer; a machine gun is mounted on a sliding carriage on the side of the observer. This arrangement is similar to that found on some Italian machines.

The hull is 12.50 m. long, 1.50 m. wide and 1.20 m. high; the step is 0.25 m. high.

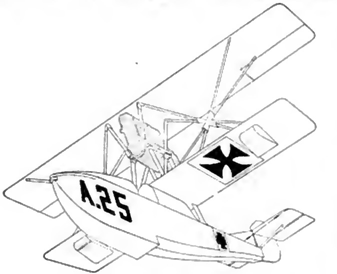
The power plant consists of a water cooled, 12-cylinder, V-type Warchalowski engine, which is rated 300 hp. and drives a pusher airscrew.

The wing pontoons, instead of being of the hemispherical shape so common on older Austrian seaplanes, have a very finely streamlined bow which thus ploughs through the surface of the water just like a ship.

The bomb carrying capacity of the K.301 is estimated at 400 kg. On examination, however, no bomb dropping device could be located for large bombs, although several hooks for smaller bombs were found. Two vertical pieces of wood, with a circular notch, were found fastened to the wing pontoons, and these may well be used for carrying large bombs, but it has not been possible to discover how they may be secured in them.

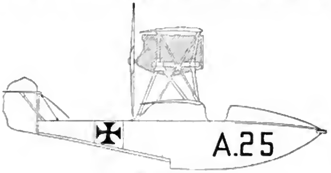
The Fighting Seaplane A.25

This machine, which was captured on May 18, 1917, and consequently reveals recent Austrian practice, does not differ much from the usual fighting seaplane type. A few constructional features are, however, worthy of note, the most striking of these being the bracing system of the wing panels. The wing panels of the A.25 are braced by what appears in front and side elevation to be an X-truss, but which really consists of eight inclined struts all of which converge toward a central fitting. This system permits to dispense with transverse and longitudinal wire bracing, because all the struts form but one rigid structure which distributes all stresses uniformly over the surface of the wings. The struts are polished steel tubes with a fairing of laminated wood less than 1 mm. thick.



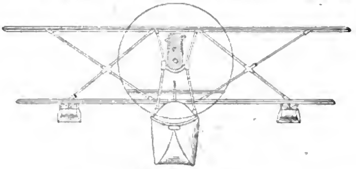
PERSPECTIVE VIEW

The two star trusses of the wing panels are furthermore connected with one another through the struts of the engine section, so that probably a greater rigidity is obtained throughout the whole lifting portion of the machine than has hitherto been achieved.



SIDE ELEVATION

The hull is carefully streamlined by a suitable laying of the side and bottom planking and shows a well worked out purpose of reducing head resistance to a minimum. This is also obvious from the streamlined casing of the engine and from the way the control cables are led, as far as possible, in the wake of the struts.



FRONT ELEVATION

The empennage is supported by two stays and two ties, and, in addition, by a vertical fin of laminated wood.

The dimensions of the machine are the following:

Overall span	8.00 m.
Interplane gap	1.65 m.
Chord	1.50 m.
Angle of incidence	about 0.
Length of hull	6.50 m.
Overall length	7.35 m.
Height above step	0.85 m.
Width at the step	0.95 m.
Overall width of hull	1.00 m.
Distance from bow to step	3.45 m.
Distance from step to stern	3.90 m.
Height of step	0.16 m.
Offset of wing pontoons from centerline	2.50 m.

The power plant is a 6-cylinder Hiero Flugmotor, made to Warchalowski's patents by the Eisler & Co., A.-G., and develops 218 hp. at 1,400 r.p.m. The engine weighs 314 kg. and is fitted with Bosch starting magnetos. The propeller is a 200 hp. Hiero. Diameter, 2.72 m.; pitch, 2.25-2.40 m.

Government Specifications for Kiln-Drying Airplane Woods

By Thomas D. Perry

Inability to secure an adequate supply of three-year, air-dried spruce for airplane work has led the Aeronautical Engineering Division of the Signal Corps of the United States Army to develop process specification number 20,500, providing for the artificial drying of lumber. Some doubt still exists as to whether the lumber kiln-dried according to the specification is in every respect as strong, rigid and elastic as the air-dried stock.

Exhaustive tests are now being conducted along this line, and the steps taken indicate the practical equality of the artificially dried with three-year air-dried.

In the preparation of specification number 20,500, the services of the Forest Products Laboratory at Madison, Wis., were enlisted. This Laboratory under United States Government auspices has been conducting a series of tests on green, air-dried and kiln-dried lumber for a period of years, and with these tests as a basis the specifications were drawn. To make them readily understandable they have been reduced by the writer to chart form, in which the vertical distances represent temperatures, and relative humidities and the horizontal spaces indicate moisture content of the lumber and days of drying. An assumption has been made in plotting the horizontal dis-

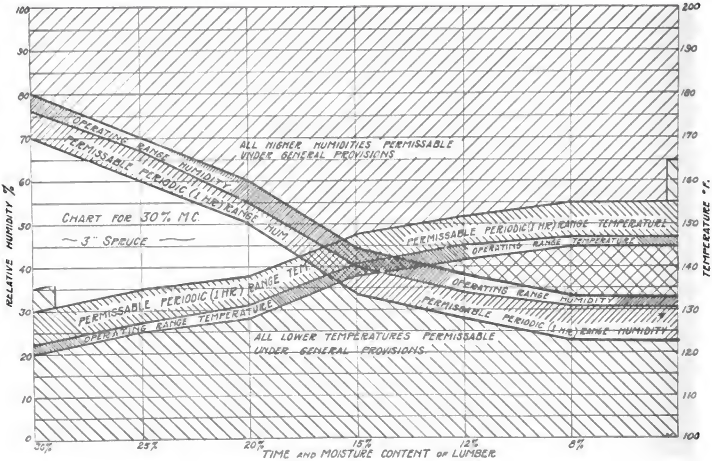


Chart I

tances that the intervals required to reduce moisture content are substantially equal, but this can cause no appreciable error.

Chart I shows the downward tendency of the humidity line and the upward slope of the temperature line, with the specified tolerances. The operating ranges, shown by densest section, are exceedingly limited, and kiln operators will need to take many more frequent operations than usual; at least six read-

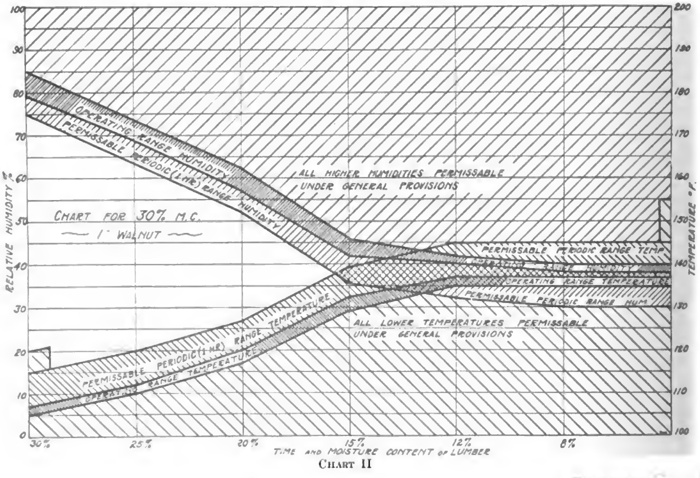


Chart II

ings every twenty-four hours. The maximum temperatures are much lower than customarily used on spruce, and the time must be correspondingly lengthened to allow 30 days for usual kilns on lumber shown in Chart I.

The initial and final steaming for moisture equalization on the surface and in the center of the board will produce high humidities, but lie in the permissible range, and are, therefore, not plotted. Some question exists in the writer's mind as to the effect of the sudden initial and final increase of temperature; probably a gradual rise would be safer.

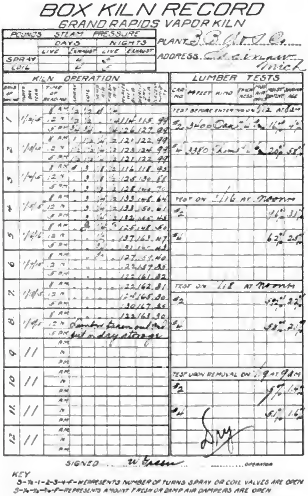
Users of vapor kilns will find that their normal humidity lines will be much higher than specified, but still within the permissible range. Safety would undoubtedly be maintained by correspondingly higher temperatures, but they cannot be used until an amendment to the present specifications is issued.

Chart II is for propeller blade stock or hardwood, and temperatures are even lower than for spruce. The lumber, however, is usually one inch thick, and can be dried in usual kilns in about 20 days.

Many kiln owners will wonder whether their present kilns can be operated within the limits of the specifications. In most instances the answer will be in the negative, for few installations possess the adequate and accurate control for temperature, humidity and circulation. The latter must provide four air changes an hour. Kilns in general have been operated carelessly and no incentive has been offered, nor encouragement given to kiln designers and manufacturers to supply kilns barred by the specification and the segregation of kinds and thicknesses of lumber is provided.

In order to facilitate the analysis of kiln records, it is suggested that operators keep a tabular record, making records as the drying process progresses. A typical record is shown in chart III. This can be varied to suit individual conditions.

A comparison with the government specifications can be readily made by plotting chart III on II, with the result shown in chart IV. The writer has intentionally taken a typical vapor kiln record, on one-inch oak at usual drying temperatures, which does not come within the specification, in order to emphasize the discrepancies and to show the relation between usual drying conditions and the government requirements.



BOX KILN RECORD
GRAND RAPIDS VAPOR KILN

POUNDS STEAM PRESSURE
DAYS NIGHTS
LIVE EXHAUST LIVE EXHAUST
SPRAY
COIL

PLANT
ADDRESS
Mich

KILN OPERATION

LUMBER TESTS

CAR NO. FEET KIND THICKNESS MOIST. CONTENT

TEST BEFORE ENTERING

TEST ON 1/16 AT NOON

TEST ON 1/18 AT NOON

TEST UPON REMOVAL ON 1/19 AT 9 A.M.

Lumber taken out and put in dry storage

Dry

SIGNED W. Green OPERATOR

KEY
3-½-1-2-3-4-F—REPRESENTS NUMBER OF TURNS SPRAY OR COIL VALVES ARE OPEN
3-¼-½-¾-F—REPRESENTS AMOUNT FRESH OR DAMP AIR DAMPERS ARE OPEN

CHART III

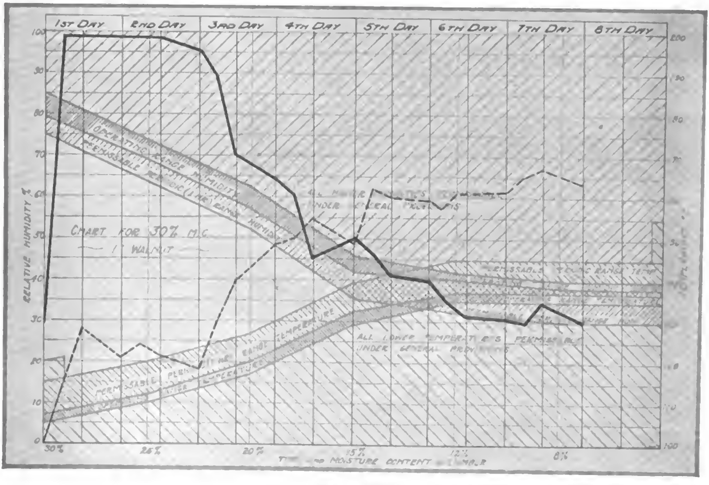


CHART IV

It is to be noted that one-inch oak and walnut take the same drying schedule.

The comparative use of tabular records such as chart III and of graphic records similar to IV is recommended. For clearness of record, the complete graphic chart for specification number 20,500 (chart II) should be printed in a faint ink, so that the actual operating lines stand out with clearness.

There is no doubt that Government inspectors will welcome the systematic use of complete records similar to the above.

Note.—Copyright privileges on charts I and II are reserved by the Grand Rapids Veneer Works.

Radiators for Airplane Engines

The Auto Radiator Manufacturing Corp., manufacturer of the "Flexo" copper core radiators has investigated the problem of airplane engine radiators in a thorough manner and some interesting results are available.

Data was obtained from field tests. Owing to the part of the country in which the tests were run, large radiators were required on account of climatic conditions. Tests were made on several radiators of each type and an average taken. Four types were considered:

(1) *Front Type:* The front type is mounted directly back of the propeller and is usually attached to the machine by means of studs from the bottom. This is a rigid mounting and if proper supports are not provided from the upper parts, the radiator will whip back and forth and cause leaks where the studs enter the lower water box, or tear the core loose where it is soldered to the tank. This type is also mounted by means of bolts through the lower part of the hood ledge. This is the better of the two ways as the strain is distributed along the sides.

When this type is used with a vertical engine it may require large upper water tanks, in which case the frontal resistance per b.h.p. run rather high.

This type also usually carries considerable water, due to the tank around the hole through which the propeller shaft passes.

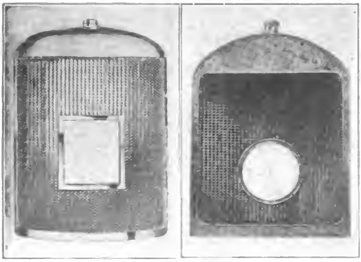


Fig. 1. Front Type

(Mounted back of Propeller)

FROM FIELD TESTS

Cooling per b.h.p.	117 sq. in.
Core per b.h.p.	0.39 lb.
Water per b.h.p.	0.42 lb.
Frontal per b.h.p.	4 sq. in.
Radiator per b.h.p.	0.51 lb.
Radiator and Water per b.h.p.	0.9 lb.

The large water box and tank around the hole, of course, add to the weight of the radiator, bringing the total weight very high.

The front type is also somewhat complicated in manufacture owing to the curved lines which conform to the shape of the body and the lines round the propeller hole. This involves extra material and labor.

(2) *Side Type*: There are many kinds of side type radiators, but ordinarily they are mounted alike on the side of the body with studs from below and attached to the struts from above by the same means. The manner of mounting is good in that there is little chance to whip.

The side type is always somewhat heavy for two reasons: Extra parts for two radiators are needed; and as the radiator is lower than the water jackets, it requires more tankage and core. The manufacturing cost of this type runs quite high but not so high as the front type, because of plain cores and less skilled labor.

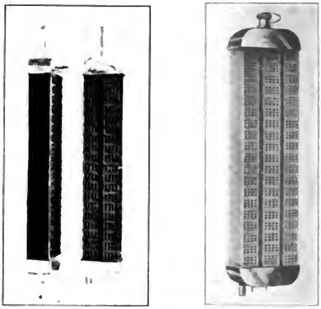


Fig. 2. Side Type

(Mounted on Side of Body)

FROM FIELD TESTS

Cooling per b.h.p.	104 sq. in.
Core per b.h.p.	0.46 lb.
Water per b.h.p.	0.25 lb.
Frontal per b.h.p.	7.2 sq. in.
Radiator per b.h.p.	0.56 lb.
Radiator and Water per b.h.p.	0.81 lb.

(3) *Overhead Type:* The overhead type is usually mounted above the aviator's head and attached by means of brackets to the struts. The location is very favorable because of its height above the engine. However, should the radiator become punctured, the aviator is liable to become scalded.

The frontal resistance is perhaps not so large because the radiator does not have to be large on account of its favorable location. The radiator hinders the lifting power of the upper plane to a certain extent.

The overhead type must be hung from the sides and owing to the fact that strong reinforcements are required, this type

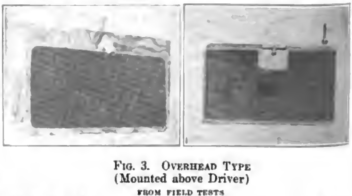


Fig. 3. Overhead Type

(Mounted above Driver)

FROM FIELD TESTS

Cooling per b.h.p.	112 sq. in.
Core per b.h.p.	0.25 lb.
Water per b.h.p.	0.31 lb.
Frontal per b.h.p.	2.7 sq. in.
Radiator per b.h.p.	0.38 lb.
Radiator and Water per b.h.p.	0.68 lb.

is excessively heavy for the work it performs. Because of its location this type must be made wide, and a large upper tank is required which increases the weight per b.h.p.

It is possible to manufacture this type without rounding the corners of the core, but more skilled labor is required because of the necessary finishing in the assembling.

(4) *Over Engine Type*: This type is mounted on the top of the engine on spring legs which are bolted to the engine by means of the cylinder head cap screws and also is supported from the top on either side from the struts, making a very good mounting. The location is favorable with the only disadvantage that it shuts off some of the aviator's view. The actual frontal resistance of this type is less by one half of that shown on the table, one core being back of the other.

The over engine type does not require large water tankage due to the long cores and has many good manufacturing points such as plain square cores, perforated strip sides, and individual water boxes soldered to the cores, and takes less skilled labor than any other type.

RESULTS OF TESTS

	Sq. In. Cooling per HP.	Wt. of Core per HP.	Wt. of Water per HP.	Frontal Sq. In. per HP.	Wt. of Radiator per HP.	Wt. of Radiator and Water per HP.
Front Type	117	.39	.42	4	.51	.9
Side Type	104	.46	.25	7.2	.56	.81
Overhead Type	112	25	.31	2.7	.38	.68
Over Engine Type	121	.31	.23	5	.39	.62

The "Flexo" radiator cores have a combination thin and wide water travel and are soldered at all points of contact. These cores are flexible and will stand severe landing shocks without injury. They can be frozen any number of times without being damaged.

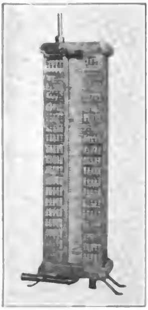
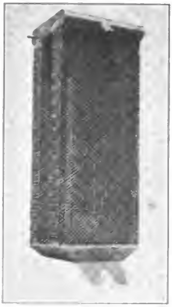



FIG. 4. OVER ENGINE TYPE
(Mounted over Engine)

FROM FIELD TESTS

Cooling per b.h.p.	121 sq. in.
Core per b.h.p.	0.31 lb.
Water per b.h.p.	0.28 lb.
Frontal per b.h.p.	5 sq. in.
Radiator per b.h.p.	0.39 lb.
Radiator and Water per b.h.p.	0.62 lb.

Slip Stream in Relation to Stability at Stalling Speeds

By A. A. Merrill

In testing a model for static longitudinal stability it is common practice to set the model up on the axis of the balance in the wind tunnel with its span vertical and the chord of its surface at the desired angle of incidence. The force down the wind, i.e., drag or K_x, and the force across the wind, i.e., lift or K_y are then measured. From these the resultant force may be computed as it equals the square root of the sum of the squares of these two forces.

Also, as the axis of the balance does not pass through the center of pressure of the model, there will be a couple about this axis which is measured by the torsion of a wire. If we divide the magnitude of this couple by the magnitude of the resultant force, we will get the vertical distance of this resultant force from the axis. We are then able to plot on a side elevation of the model the position of this resultant force since we know its line of action, point of application, direction and magnitude.

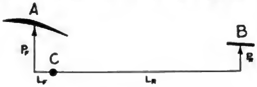


FIG. 1

We do this for all flying angles and we get a series of lines called force vectors and from this series we can determine the static stability of the model. Thus, a model is statically stable if the vectors follow the progression of the angles of incidence, i.e., if the vector for 2 deg. is behind that for 1 deg., the vector for 3 deg. behind that for 2 deg. and so on.

In practice these vectors generally converge upward which means that the center of gravity must lie below the point of convergence if the machine is to be stable. This, of course, is common knowledge to all familiar with laboratory work in aeronautics.

It is generally supposed that the position of the vectors is constant for a given model regardless of air speed, but this is not true unless the machine is gliding without power. With power the velocity of the slip stream alters the position of the vectors. And this fact may show how a machine may tend to stall with loss of power.

In Fig. 1, let *A* be the main surface, *B* the tail and *C* the center of gravity. If the machine is flying at a large angle, the resultant pressure on the main surface lies forward of the center of gravity and tends to stall the machine, while the force on the tail tends to maintain equilibrium. The forces are shown to be vertical merely for the sake of illustration. The equation of equilibrium is $PFLF = PRLR$.

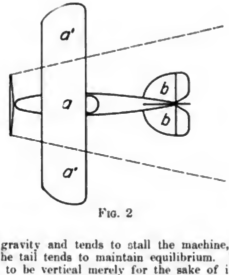


FIG. 2

In Fig. 2 is shown the approximate sphere of action of the propeller slip stream. When power is shut off, it is only the center part of the wing that is affected, but the lift on the whole of the tail surfaces is diminished, even though the tail is so far from the propeller that slip stream affects it less than the wings. It is possible, therefore, that the lift on the main surfaces may be diminished by a smaller fraction than lift on tail surfaces, and the equilibrium is broken, so that there is a tendency to stall.

International Aircraft Standards

(Continued from last issue)

3S28—Specifications for Alloy Steel Sheet

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. The material for these sheets shall be chosen from the I. A. S. B. standard alloy steels listed below. The composition shall be stated by the manufacturer or contractor and is further limited as follows: Carbon, not over 0.25 per cent.

Manufacture.—3. (*a*) The steel shall be manufactured, or at least finished, by the open-hearth, electric-furnace, or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) Sheets, unless ordered cold-rolled, shall be full pickled.

(*d*) Sheets are to be well and uniformly annealed in accordance with good commercial practice. For sheets lighter than 0.065 in. (1.65 mm.), box annealing is preferred. For sheets 0.065 in. (1.65 mm.) and thicker, open annealing is preferred.

Heat Treatment.—(*e*) The manufacturer shall state the heat treatment recommended to give the physical properties specified.

Workmanship and Finish.—4. (*a*) The sheets must be commercially flat, clean, smooth, free from seams, laminations, blisters, and other surface defects. They must be uniform in quality, and within the stipulated margins of manufacture.

(*b*) Any sheet may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously been accepted by the inspector; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—5. (*a*) Specimens cut in any direction from the heat-treated sheets shall have the following properties:

Tensile Test.—(*b*) Minimum tensile strength, 100,000 lb. per sq. in. (70.30 kg./mm.^{2}); minimum yield point, 75,000 lb. per sq. in. (52.73 kg./mm.^{2}); minimum elongation, 15 per cent in 4 in. (101.6 mm.).

Bend Test.—(*c*) Strips cut from annealed sheets shall stand being bent cold through an angle of 180 deg., in any direction, to a radius equal to the thickness of the sheet without fracture.

(*d*) Strips 1¼ in. (31.75 mm.) wide cut from annealed sheets, and with edges rounded, shall stand reversed bending, cold, through an angle of 90 deg. for not less than three complete reversals, without fracture. The test is to be made in a square-nose vise, the edges over which the specimen is bent being rounded to a radius equal to three times the thickness of the sheet.

Selection of Test Specimens.—6. Three sheets shall be taken from each annealing box to represent the top, middle, and bottom of the stack, or 1 sheet from each 25 when sheets are open annealed. One tensile, one bending, and one reverse bending test shall be made from each sheet selected.

Dimensions and Tolerances.—7. The dimensions and tolerances shall be those given in the table below and in the specifications 3S11. The thickness will be specified in decimals of an inch or millimeters.

Delivery, Packing, and Shipping.—8. (*a*) Sheets shall be cut to the required dimensions and shall be ordered in as narrow widths as can be used.

(*b*) All sheets shall be oiled for protection against corrosion.

(*c*) Sheets 0.065 in (1.65 mm.) or thinner shall be boxed, the weight of the box with contents not to exceed 220 lb. (100 kg.).

(*d*) Sheets thicker than 0.065 in. (1.65 mm.), up to and including 0.125 in. (3.18 mm.), shall be crated, the weight of crate and contents not to exceed 220 lb. (100 kg.).

(*e*) Sheets thicker than 0.125 in. (3.18 mm.) may be bundled, the weight of bundle not to exceed 220 lb. (100 kg.).

CHEMICAL COMPOSITION OF STANDARD ALLOY STEELS.

Nickel Steels.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium
2315	0.10-0.20	0.30-0.60	0 040	0 045	3 25-3.75	......
2320	.15- .25	.30- 60	.040	.045	3.25-3.75	......
2325	.20- .30	.50- 80	.040	.045	3.25-3 75	......

Nickel-Chromium Steels.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium.
3120	0.15-0.25	0.30-0.60	0 040	0 045	1 00-1 50	0.45-0.75
3215	.10- .20	.30- .50	.040	.045	1.50-2 00	90-1.25
X3315	10- .20	.30- 60	.040	.045	2.75-3 25	.70- 95
3315	.10- .20	.30- .60	.040	.045	3.25-3.75	1 25-1.75

Chromium-Vanadium Steels.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Chromium.	Vanadium minimum.
6120	0.15-0.25	0.30-0 60	0.040	0.045	0.60-0 90	0 15

When electric or crucible furnace steel is specified in the order, the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

TABLE OF TOLERANCES FOR STANDARD STEEL SHEETS.

Thickness.		Tolerance for sheets 14 inches (35.6 cm.) wide and under.		Tolerance for sheets over 14 inches (35.6 cm.) wide.	
Inches.	*Millimeters.*	*Inches.*	*Millimeters.*	*Inches.*	*Millimeters.*
0-0.020	0.51	+0.001 − .002	+0.03 + .05	±0 002	±0.05
0.021- .030	0.54- .76	+ .002 − .003	+ .05 − .08	± .003	± .08
.031- .040	.79-1.02	± .003	± .08	± .003	± .08
.041- .050	1.05-1.27	± .003	± .08	± .004	± .10
.051- .065	1.30-1.65	± .004	± .10	± .004	± .10
.066- .080	1.68-2.03	± 004	± .10	± .005	± .13
.801- .100	2.06-2.54	± .006	± .15	± .006	± .15
.101- .120	2 57-3.05	± .006	± .15	± .007	± .18
.121- .250	3.08-6.35	± .006	± 15	± 008	± .20

3S18—Specifications for Alloy Steel Bars and Billets for Case Hardening

(130,000 Lbs. Per Sq. In. Tensile Strength.)

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. The material for these bars shall be chosen from among the I. A. S. B. standard alloy steels listed below. The composition chosen shall be stated by the manufacturer or contractor; it is further limited as follows: Carbon, not over 0.25 per cent.

Manufacture.—3. (*a*) The steel shall be manufactured or at least finished by the open-hearth, electric furnace, or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar. No undercutting in chipping will be allowed.

(*d*) The steel manufacturer shall state the heat treatment recommended for case hardening this steel and to give the physical properties specified.

Workmanship and Finish.—4. (*a*) The bars are to be sound, commercially straight, free from pipes, laps, cracks, twists, seams, and damaged ends, and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture, capable of being turned and threaded readily and of taking a good finish.

(*b*) Any article may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously been accepted by the inspector; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—5. The bars shall have the following physical properties:

Tensile Test.—(*a*) Minimum tensile strength, 130,000 lb. per square inch (91.39 kg./mm.^{2}); minimum yield point, 120,000 lb. per square inch (84.36 kg./mm.^{2}); minimum elongation in 2 in. (50.8 mm.) or proportional gage length, 18 per cent.

Hardness Test.—(*b*) After carbonizing and tempering, the case must show a minimum Shore scleroscope hardness number of 75.

Impact Test.—(*c*) When impact testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture of the core in foot-pounds (or kilogram-meters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat-treatment) of the material.

Selection of Test Specimens.—6. Three bars of each size rolled from a heat shall be taken and test pieces prepared in accordance with the I. A. S. B. standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended by the steel manufacturer, fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser, the steel manufacturer may recommend a different heat treatment for the second set of test specimens, and to that end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the final tests fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected.

Dimensions and Tolerances.—7. The dimensions and tolerances shall be those of the specifications 3S11.

Delivery, Packing, and Shipping.—8. (*a*) The bars shall be delivered in the annealed state.

(*b*) The bars shall in general be grouped in bundles weighing not more than 250 lb. (113.4 kg.), unless otherwise agreed between manufacturer and purchaser; the heat number and the I. A. S. B. steel serial numbers shall be plainly marked on a metal tag attached to each bundle. If bars are not so grouped and bundled, each bar shall be plainly marked with the heat number and the I. A. S. B. steel serial number.

CHEMICAL COMPOSITION OF STANDARD ALLOY STEELS.

Nickel Steels.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium
2315	0.10-0.20	0.30-0.60	0.040	0.045	3.25-3.75	......
2320	.15-.25	.30-.60	.040	.045	3.25-3.75	......

Nickel-Chromium Steels.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel	Chromium.
3120	0.15-0.25	0.30-0.60	0.040	0.045	1.00-1.50	0.45-0.75
3215	.10-.20	.30-.50	.040	.045	1.50-2.00	.90-1.25
X3315	.10-.20	.30-.60	.040	.045	2.75-3.25	.70-.95
3315	.10-.20	.30-.60	.040	.045	3.25-3.75	1.25-1.75

Chromium-Vanadium Steels.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Chromium.	Vanadium minimum.
6120	0.15-0.25	0.30-0.60	0.040	0.045	0.60-0.90	0.15

When electric or crucible furnace steel is specified, the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

3S11—Tolerances on Steel Bars, Sheets, Tubes, Wires and Cables

The following table and text indicate the tolerances which will be considered standard for the I. A. S. B.:

TABLE 1.

Standard Steel Bars, Round or Square.

Hot rolled. Size of bar (diameter or width across flats.) Inches.	Millimeters.	Tolerance. Inch.	Millimeters.	Bright rolled and drawn. Size of bar (diameter or width across flats.) Inches.	Millimeters.	Tolerance. Inch.	Millimeter.
0-0.875	0-22.23	+0.010	+0.25	0-0.563	0-14.30	−0.002	−0.05
0.876-1.250	22.25-31.75	+ .015	+ .38	0.564-1.125	14.33-28.58	− .003	− .08
1.251-1.625	31.78-41.28	+ .020	+ .51	1.126-1.875	28.60-47.63	− .004	− .10
1.626-1.875	41.30-47.63	+ .025	+ .64	1.876-3.000	47.65-76.20	− .005	− .13
1.876-3.000	47.65-76.20	+ .050	+1.27	3.001-4.000	76.23-101.60	− .006	− .15
3.001-4.000	76.23-101.60	+ .075	+1.91	4.001-5.000	101.63-127.00	− .007	− .18
4.001-5.000	101.63-127.00	+ .100	+2.54	5.001	127.03	− .008	− .20
5.001	127.03	+ .150	+3.81				

TABLE 2.

Standard Steel Bars, Hexagon.

Hot rolled. Size of bar (width across flats). Inches.	Millimeters.	Tolerance. Inch.	Millimeters.	Bright rolled and drawn. Size of bar (width across flats). Inches.	Millimeters.	Tolerance. Inch.	Millimeter.
0-0.875	0-22.23	+0.010	+0.25	0-0.563	14.30	−0.002	−0.05
0.876-1.250	22.25-31.75	+ .015	+ .38	0.564-0.938	14.32-23.83	− .003	− .08
1.251-2.000	31.78-50.80	+ .020	+ .51	0.939-2.000	23.85-50.80	− .004	− .10
2.001-3.000	50.83-76.20	+ .025	+ .64	2.001-3.000	50.83-76.20	− .005	− .13
3.001	76.23	+ .030	+ .76	3.001	76.23	− .006	− .15

TABLE 3.

Standard Steel Sheets.

Thickness. Inch.	Millimeters.	Tolerance for sheets 14 inches (355.6 mm.) wide and under. Inch.	Millimeter.	Tolerance for sheets over 14 inches (355.6 mm.) wide. Inch.	Millimeter.
00-.020	0-0.51	+0.001 − .002	+0.03 − .05	±0.002	±0.05
0.021-.030	0.53-.76	+ .002 − .003	+ .05 − .08	± .003	± .08
.031-.040	.79-1.02	± .003	± .08	± .003	± .08
.041-.050	1.04-1.27	± .003	± .08	± .004	± .10
.051-.065	1.30-1.65	± .004	± .10	± .004	± .10
.066-.080	1.68-2.03	± .004	± .10	± .005	± .13
.081-.100	2.06-2.54	± .006	± .15	± .006	± .15
.101-.120	2.57-3.05	± .006	± .15	± .007	± .18
.121-.250	3.07-6.35	± .006	± .15	± .008	± .20

Steel Tubes—1. The following tolerances will be allowed on the outside diameter of tubes:

Seamless tubes:
For tubes under 1.5 in. (38.1 mm.) diameter ± 0.003 in. (0.08 mm.).
For tubes over 1.5 in. (38.1 mm.) diameter ± 0.005 in. (0.13 mm.).
Welded tubes:
For tubes under 1.5 in. (38.1 mm.) diameter ± 0.005 in. (0.13 mm.).
For tubes over 1.5 in. (38.1 mm.) diameter ± 0.010 in. (0.25 mm.).

The tolerances on coulissant or telescoping tubes shall be decided between manufacturer and purchaser.

The permissible limit of variation of wall thickness shell be 10 per cent of the dimensions specified.

Wires and Cables—2. The following tolerances will be allowed on wires and cables:

High-Strength Steel Wire—(*a*) A permissible variation of 0.002 in. (0.051 mm.) above gauge on all sizes will be accepted, but no wire will be accepted having a variation of more than 0.0005 in. (0.013 mm.) below gauge.

19 Nonflexible Steel-Wire Cable—(*b*) There shall be no permissible variation in diameter below size. Cable having a diameter of 0.031 ( ) to 0.156 (5/32) in. (0.79 to 3.97 mm.), inclusive, shall have a permissible variation of 10 per cent above size, and cable having a diameter of 0.1875 (3/16) to 0.375 (3/8) in. (4.76 to 9.53 mm.), inclusive, shall have a permissible variation of 7 per cent above size.

7 × 7 *Flexible Steel-Wire Cable*—(*c*) There shall be no permissible variation in diameter below size. Cable having a diameter of 0.063 (1/16) to 0.094 (3/32) in. (1.59 to 2.38 mm.), inclusive, shall have a permissible variation of 12 per cent above size; cable having a diameter of 0.125 (1/8) to 0.187 (3/16) in. (3.18 to 4.76 mm.), inclusive, shall have a permissible variation of 10 per cent above size; and cable having a diameter of 0.2187 (7/32) to 0.375 (3/8) in. (5.56 to 9.53 mm.), inclusive, shall have a permissible variation of 7 per cent above size.

7 × *19 Extra Flexible Steel-Wire Cable*—(*d*) there shall be no permissible variation in diameter below size. Cable having a diameter of 0.125 (1/8) to 0.187 (3/16) in. (3.18 to 4.76 mm.), inclusive, shall have a permissible variation of 10 per cent above size; and cable having a diameter of 0.218 (7/32) to 0.375 (3/8) in. (5.56 to 9.53 mm.), inclusive, shall have a permissible variation of 7 per cent above size.

4P2—Specifications for Aircraft Ferrules and Thimbles

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. Thimbles shall be manufactured of I. A. S. B. standard No. 1010 steel sheet, cold rolled and annealed.

Ferrules shall be manufactured of the same steel as is used for the wire, namely, I. A. S. B. standard steels No. 1065, No. 1070, or No. 1080.

MANUFACTURE.—3. (*a*) Steel wire for winding into ferrules shall be uniformly coated with pure tin to solder readily.

(*b*) All thimbles shall be smoothly and evenly electro-galvanized.

DIMENSIONS AND TOLERANCES.—4. (*a*) Ferrules and thimbles shall conform within limits specified to the dimensions given in the tables and drawings.

(*b*) The manufacturer shall provide hardened pin gages for all sizes of thimbles and ferrules and such gages, after being approved by the Government, shall be used by the inspectors for determining all internal dimensions and shapes.

DELIVERY, PACKING, AND SHIPPING.—5. (*a*) Ferrules and thimbles shall be packed and shipped in fiber or pasteboard boxes containing 1,000 each.

(*b*) A label on each box shall be marked with order number or other distinguishing marks, size, material, evidence of inspection, etc., as required.

INSPECTION AND REJECTION.—6. The inspector shall examine one sample taken at random from a box of 1,000 ferrules or thimbles and determine whether it conforms to these specifications.

I. A. S. B. STANDARD TINNED STEEL AIRCRAFT FERRULES.

ENGLISH UNITS.

American Wire Gage (B. & S.)	A and B.	D.	E.	Approximate weight, 1,000 pieces.
	Inch.	*Inch.*	*Inch.*	*Pounds.*
8	0.128	0.130	0.260	34.50
9	.114	.116	.232	23.00
10	.102	.104	.208	17.00
11	.091	.093	.186	11.75
12	.081	.083	.166	8.50
13	.072	.074	.148	6.03
14	.064	.066	.132	4.50
15	.057	.059	.118	3.10
16	.051	.053	.106	2.09

METRIC UNITS.

American Wire Gage (B. & S.	A and B.	D.	E.	Approximate weight, 1,000 pieces
	mm.	*mm.*	*mm.*	*kg.*
8	3.25	3.30	6.60	15.65
9	2.91	2.96	5.92	10.43
10	2.59	2.64	5.28	7.71
11	2.31	2.36	4.72	5.33
12	2.05	2.10	4.20	3.86
13	1.83	1.88	3.76	2.74
14	1.63	1.68	3.36	2.04
15	1.45	1.50	3.00	1.41
16	1.29	1.34	2.68	.95

Dimensions A and B (see Fig. 1) are minimum allowance + 0.002 in. (0.05 mm.).

The section of gage bar having semicircular edges, as shown in Fig. 2, shall pass through ferrules with a clearance of approximately 0.003 in. (0.08 mm.).

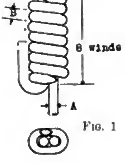


FIG. 1

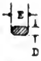


FIG. 2

I. A. S. B. STANDARD GALVANIZED STEEL AIRCRAFT THIMBLES.

ENGLISH UNITS.

Size.	A.	B.	C.	D.	E.	Approximate weight, 1,000 pieces.
Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Pounds.*
1/16 and 3/32	0.35	0.70	0.07	0.09	0.032	3.00
1/8	.35	.70	.07	.13	.032	4.34
5/32	.40	.80	.10	.17	.032	6.36
3/16	.50	1.00	.135	.21	.032	9.00
7/32	.60	1.20	.15	.24	.032	13.50
1/4	.70	1.40	.17	.25	.032	16.63
9/32	.80	1.60	.198	.30	.040	30.36
5/16	.90	1.80	.21	.33	.040	33.00
3/8	1.00	2.00	.26	.39	.060	74.00

METRIC UNITS.

Size.	A.	B.	C.	D.	E.	Approximate weight, 1,000 pieces.
mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*kg.*
1.59 and 2.38	8.89	17.78	1.78	2.29	0.81	1.36
3.18	8.89	17.78	1.78	3.30	.81	1.97
3.97	10.16	20.32	2.54	4.32	.81	2.88
4.76	12.70	25.40	3.43	5.33	.81	4.08
5.56	15.24	30.48	3.81	6.10	.81	6.12
6.35	17.78	35.56	4.32	6.35	.81	7.54
7.14	20.32	40.64	5.03	7.62	1.02	13.77
7.94	22.86	45.72	5.33	8.38	1.02	14.97
9.53	25.40	50.80	6.60	9.91	1.52	33.57

Tolerance on dimension A (see Fig. 3) shall be + 0.01 in. (0.25 mm.).

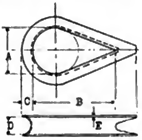


FIG. 3

3S23—*Specifications for Medium Carbon Steel Tubes*

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

USE.—2. These tubes are suitable for stressed parts, such as braces and tie tubes.

MATERIAL.—3. The I. A. S. B. standard steel No. 1035 shall be used. Its composition is as follows:

	Per cent
Carbon	0.30-0.40
Manganese	.50- .80
Phosphorus, maximum	.045
Sulphur, maximum	.050

MANUFACTURE.—4. (*a*) The tubes are to be of the cold-drawn seamless type.

Heat Treatment—(*b*) The tubes shall be heat treated to give the physical properties specified. It is desirable that they be quenched in oil.

(*c*) Any tube may be rejected at any time because of injurious defects or faults in the steel which are revealed by manufacturing operations, notwithstanding the fact that it has previously passed inspection. Such rejected material shall be returned to the manufacturer at the latter's expense. This clause shall not apply to materials fabricated after export.

WORKMANSHIP AND FINISH.—5. The tubes are to be smooth, of the section specified, and within the permissible tolerances as to wall thickness, of uniform diameter, free from scale, dirt, specks, longitudinal seaming, lamination, grooving, and blistering, both internally and externally.

PHYSICAL PROPERTIES AND TESTS.—6. The tubes shall have the following physical properties:

Tensile Test—(*a*)

Minimum tensile strength, 80,000 lb. per square in. (56.24 kg./mm²).

Minimum yield point, 60,000 lb. per square in. (42.18 kg./mm²).

Minimum elongation, either 20 per cent in 2 in. (50.8 mm.) or 12 per cent in 8 in. (203.2 mm.).

Crushing Test—(*b*) The test specimen shall be crushed endwise until the outside diameter is increased in one zone by 25 per cent, or until one complete fold is formed. The specimen shall stand this treatment without cracking.

SELECTION OF TEST SPECIMENS—7. One test specimen for the tensile test shall be chosen from every 400 ft. (121.9 m.) of tubing and one test supecimen for the crushing test from every 100 ft. (30.5 m.) of tubing.

The specimens for the crushing tests shall have a length of 1.5 times the diameter of the tube.

Whenever possible the selection of test specimens shall be made by heats.

DIMENSIONS AND TOLERANCES—8. (*a*) The following tolerances will be allowed on the outside diameter of tubes:

Tubes under 1.5 in. (38.1 mm.) diameter, ± 0.003 in. (0.08 mm.).

Tubes over 1.5 in. (38.1 mm.) diameter, ± 0.005 in. (0.13 mm.).

The manufacturer and purchaser shall agree upon tolerances for coulissant or telescoping tubes.

(*b*) The variation in wall thickness may be ± 10 per cent of the dimension specified.

(*c*) In no part of any tube shall the departure from straightness exceed 1 in 600.

DELIVERY, PACKING, AND SHIPPING—9. All tubes shall be well oiled and delivered in boxes not exceeding 220 lb. (100 kg.) gross weight.

3S21—*Specifications for Welded Steel Tubes*

GENERAL—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

USE—2. These tubes are suitable only for unstressed parts, such as conduit tubes.

MATERIAL—3. The I. A. S. B. standard steel No. 1020 shall be used. Its composition is as follows:

	Per cent.
Carbon	0.15-0.25
Manganese	.30- .60
Phosphorus, maximum	.045
Sulphur, maximum	.050

Manufacture—4. All tubes shall be of the welded type. They must be carefully annealed before the final pass.

Any tube may be rejected at any time because of injurious defects or faults in the steel which are revealed by manufacturing operations, notwithstanding the fact that it has previously passed inspection. Such rejected material shall be returned to the manufacturer at the latter's expense. This clause shall not apply to materials fabricated after export.

Woakmanship and Finish—5. The tubes are to be smooth, of the section specified, and within the permissible tolerances as to wall thickness, of uniform diameter, free from scale, dirt, specks, longitudinal seaming, lamination, grooving, and blistering, both internally and externally.

Physical Properties and Tests—6. The tubes shall have the following physical properties:

Crushing Test—One test specimen from every 100 ft. (30.5 m.) of tubing is to be crushed endwise until the outside diameter is increased in one zone by 25 per cent, or until one complete fold is formed. The specimen shall stand this treatment without cracking.

Whenever possible the selection of test specimens shall be made by heats.

The specimens for the crushing tests shall have a length of 1.5 times the diameter of the tube.

Dimensions and Tolerances—7. (*a*) The following tolerances will be allowed on the outside diameter of tubes:

Tubes under 1.5 in. (38.1 mm.) diameter, ± 0.005 in. (0.13 mm.).
Tubes over 1.5 in. (38.1 mm.) diameter, ± 0.010 in. (0.25 mm.).

(*b*) The variation in wall thickness may be ± 10 per cent of the dimension specified.

(*c*) In no part of any tube shall the departure from straightness exceed 1 in 600.

Delivery, Packing, and Shipping—8. All tubes shall be well oiled and delivered in boxes not exceeding 220 lb. (100 kg.) gross weight.

3S24—Specifications for Alloy Steel Tubes

General—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Use—2. These tubes are suitable for axle and parts subject to shock.

Material—3. The material for these tubes shall be chosen from I. A. S. B. standard steels listed below. The composition chosen shall be stated by the manufacturer and is further limited as follows: Carbon, not over 0.35 per cent.

Manufacture—4. (*a*) The tubes are to be of the cold-drawn, seamless type. To avoid overhardening after annealing the tube wall shall not be reduced more than 20 per cent in thickness in the final passes.

Heat Treatment—(*b*) The tubes shall be heat treated to temper 1 or 2 as ordered. The quenching is to be done in oil.

(*c*) Any tube may be rejected at any time because of injurious defects or faults in the steel which are revealed by manufacturing operations, notwithstanding the fact that it has previously passed inspection. Such rejected material shall be returned to the manufacturer at the latter's expense. This clause shall not apply to materials fabricated after export.

Workmanship and Finish—5. The tubes are to be smooth, of the section specified, and within the permissible tolerances as to wall thickness; of uniform diameter, free from scale, dirt, specks, longitudinal seaming, lamination, grooving, and blistering, both internally and externally.

Physical Properties and Tests—6. The tubes shall have the following physical properties:

Tensile Test—(*a*)

Temper 1.

Minimum tensile strength, 110,000 lb. per sq. in. (77.33 kg./mm.^{2}).
Minimum yield point, 90,000 lb. per sq. in. (63.27 kg./mm.^{2}).
Minimum elongation, 15 per cent in 2 in. (50.8 mm.) or 5 per cent in 8 in. (203.2 mm.).

Temper 2

Minimum ultimate strength, 85,000 lb. per sq. in. (59.76 kg./mm.^{2}).
Minimum yield point, 60,000 lb. per sq. in. (42.18 kg./mm.^{2}).
Minimum elongation, 25 per cent in 2 in. (50.8 mm.) or 10 per cent in 8 in. (203.2 mm.).

Crushing Test—(*b*) The test specimen shall be crushed endwise until the outside diameter is increased in one zone by 25 per cent, or until one complete fold is formed. The specimen must stand this treatment without cracking.

Selection of Test Specimens—7. One test specimen for the tensile test shall be chosen from every 400 ft. (121.9 m.) of tubing and one test specimen for the crushing test from every 100 ft. (30.5 m.) of tubing.

The specimens for the crushing tests shall have a length of 1.5 times the diameter of the tube.

Whenever possible the selection of test specimens shall be made by heats.

Dimensions and Tolerances—8. (*a*) The following tolerances will be allowed on the outside diameter of tubes:

Tubes under 1.5 in. (38.1 mm.) diameter, ± 0.003 in. (0.08 mm.).
Tubes over 1.5 in. (38.1 mm.) diameter, ± 0.005 (0.13 mm.).

The manufacturer and purchaser shall agree upon tolerances for coulissant or telescoping tubes.

(*b*) The variation in wall thickness may be ± 10 per cent of the dimension specified.

(*c*) In no part of any tube shall the departure from straightness exceed 1 in 600.

Delivery, Packing, and Shipping—9. All tubes shall be well oiled and delivered in boxes not exceeding 220 lb. (100 kg.) gross weight.

CHEMICAL COMPOSITION OF STANDARD ALLOY STEELS.

Nickel Steels.

No.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium.
2320	.15- .25	.30- .60	.040	.045	3.25-3.75	
2325	.20- .30	.50- .80	.040	.045	3.25-3.75	
2330	.25- .35	50- 80	040	.045	3.25-3.75	

Chromium Vanadium Steels.

No.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Chromium.	Vanadium, minimum.
6120	0.15-0.25	0.30-0.60	0.040	0.045	0.60-0.90	0.15
6130	25- .35	.50- .80	.040	.045	.80-1.10	.15

4P1—Specifications for Turnbuckles

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Material.—2. Barrels shall be made of naval brass or equivalent alloy, I. A. S. B. specifications 3N4. The shanks shall be made of steel, I. A. S. B. specifications 3S4.

Physical Properties and Tests.—3. (*a*) At least 2 per cent of all turnbuckles shall be subjected to the test load given in the table and must withstand this test.

Steel turnbuckle shanks shall be heat treated to withstand the test loads specified.

(*b*) A bent test shall be made upon a (unbroken) shank of each turnbuckle tested in tension; the shank must withstand bending through 90 deg. without cracking.

Dimensions and Tolerances.—4. Dimensions and tolerances are given in the tables following.

When electric or crucible furnace steel is specified in the order, the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

Assembly.—5. The threads are to be greased and must have a snug true fit allowing the barrel or shank to be turned by hand and showing absolutely no slackness in fit or perceptible end shake when the ends have been extended three threads from the barrel.

Finish.—6. Turnbuckle shanks shall be thoroughly covered with a suitable noncorrosive grease before shipment. Before inspection of the finished turnbuckles they may, if so specified, be copper plated in order that initial stress in the barrel may be detected. After this inspection turnbuckles shall be greased or shall be coated with an air-drying enamel as specified.

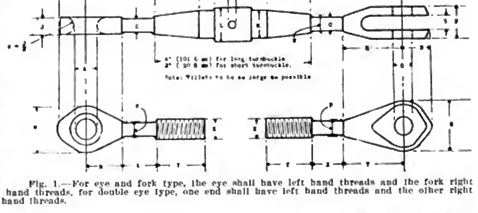


Fig. 1.—For eye and fork type, the eye shall have left hand threads and the fork right hand threads, for double eye type, one end shall have left hand threads and the other right hand threads.

DIMENSIONS IN INCHES

I. A. S. B. No.	Strength in pounds	Eye end.										Fork end.								Barrel.			Threads per inch, U. S. standard.
		C +0.001 −0.002	E	X +0.005 −0.005	Y +0.010 −0.000	A +0.002 −0.000	B +0.005 −0.005	J +0.005 −0.002	K +0.005 −0.005	R +0.005 −0.005	W +0.005 −0.005	B +0.005 −0.005	D +0.002 −0.000	F +0.015 −0.000	G +0.015 −0.000	H +0.005 −0.005	P +0.005 −0.005	S +0.005 −0.005	T +0.005 −0.005	L +0.005 −0.005	M +0.005 −0.004	N +0.005 −0.005	
1 A	1,500	0.130	0.203	0.500	0.500	0.219	0.250	0.188	0.219	0.281	0.500	0.275	0.156	0.313	0.110	0.300	0.219	0.500	0.560	0.375	0.281	0.208	30
1 B	1,500	.130	.203	1.531	.500	.219	.250	.188	.219	.281	.500	.275	.156	313	.110	.300	.219	.500	.560	.375	.281	.208	30
1 C	1,500	.130	.203	.500	.500	.219	.250	.188	.219	.281	.500	...	...	...	...	...	...	...	...	.375	.281	.208	30
1 D	1,500	130	.203	1.531	.500	.219	250	.188	.219	.281	.500	...	...	...	...	...	...	...	...	.375	.281	.208	30
2 A	2,150	.157	.203	.500	.563	.219	.328	.188	.219	.313	.500	.328	.188	.313	.110	.438	.219	500	.625	.375	.328	.281	30
2 B	2,150	.157	.203	1.531	.563	.219	.328	.188	.219	.313	.500	.328	.188	313	.110	.500	.219	.500	.657	.375	.328	.281	30
2 C	2,150	.157	.203	.500	.563	.219	.328	.188	.219	.313	.500	a.328	a.188	...	...	...	...	...	...	.375	.328	.281	30
2 D	2,150	.157	.203	1.531	.563	.219	.328	.188	.219	.313	.500	...	...	...	...	...	...	...	...	.375	.328	.281	30
3 A	3,000	.185	.231	.500	.625	.281	.391	.219	.250	.375	.625	.391	.250	.344	.110	.625	.250	.625	.813	.453	.391	.313	28
3 B	3,000	.185	.231	1.375	.625	.281	.391	.219	.250	.406	.625	.391	.250	.344	.110	.625	.250	625	.813	.453	.391	.313	28
3 C	3,000	.185	.231	.500	.625	.281	.391	.219	.250	.375	.625	a.391	a.250	...	...	...	...	...	...	.453	.391	.313	28
3 D	3,000	.185	.231	1.375	.625	281	.391	.219	.250	.406	.625	...	...	...	...	...	...	...	...	.453	.391	.313	28
4 A	4,000	.213	.265	.500	.688	.344	.422	.250	.281	.500	.688	422	.250	.438	203	.625	.281	.688	.875	.500	.438	.375	26
4 B	4,000	.213	.265	1.250	.688	.344	.422	.250	.281	.500	.688	.422	.250	.438	.203	.625	.281	.688	.875	.500	.438	.375	26
4 C	4,000	.213	.265	.500	.688	.344	.422	.250	.281	.500	.688	...	...	...	...	...	...	...	...	.500	.438	.375	26
4 D	4,000	.213	.265	1.250	.688	.344	.422	.250	.281	.500	.688	...	...	...	...	...	...	...	...	.500	.438	.375	26
5 A	5,750	.256	.313	.500	.750	.313	.469	.281	.313	.563	.750	.469	.281	.563	.203	.625	.313	.750	.875	.531	.484	.438	24
5 B	5,750	.256	.313	1.250	.750	313	.469	.281	.313	.563	.750	.469	.281	.563	.203	625	.313	.750	.875	.531	.484	.438	24
5 C	5,750	.256	.313	.500	.750	.313	.469	.281	.313	.563	.750	...	...	...	...	...	...	...	...	531	.484	.438	24
5 D	5,750	.256	.313	1.250	.750	.313	.469	.281	.313	.563	.750	...	...	...	...	...	...	...	...	531	.484	.438	24
6 A	8,400	.318	.375	.500	.875	.313	.500	.328	.375	.625	.875	.500	.313	.563	.266	.563	.375	.875	.875	625	.594	.469	22
6 B	8,400	.318	.375	1.125	.875	.313	.500	.328	.375	.625	.875	.500	.313	.563	.266	.563	.375	.875	.875	.625	.594	.469	22
6 C	8,400	.318	.375	.500	.875	b.313	.500	.328	.375	.625	.875	...	...	...	...	...	...	...	...	625	.594	.469	22
6 D	8,400	.318	.375	1.125	.875	.313	.500	.328	.375	.625	.875	...	...	...	...	...	...	...	...	.625	.594	.469	22

a When a turnbuckle has two eye ends with different size holes for the pin and cable, the two diameters are given.
b This turnbuckle is to be bored to receive pin on one end only.

DIMENSIONS IN MILLIMETERS.

I. A. S. B. No.	Strength in kilograms.	Eye end.										Fork end.								Barrel.			Threads per inch, U. S. standard.
		C +0.03 − .05	E	X +0.13 − .13	Y +1.02 − .00	A +0.05 − .00	B +0.13 − .13	J +0.13 − .05	K +0.13 − .13	R +0.13 − .13	W +0.13 − .13	B +0.13 − .13	D −0.05 − .00	F +0.38 −.00	G +0.38 − .00	H +0.13 − .13	P +0.13 − .13	S +0.13 − .13	T +0.13 − .13	L +0.13 − .13	M +0.13 − .13	N +0.13 − .13	
1 A	680.4	3.30	5.16	12.70	12.70	5.56	6.35	4.76	5.56	7.14	12.70	6.99	3.97	7.94	2.79	7.62	5.56	12.70	14.22	9.53	7.14	5.28	30
1 B	680.4	3.30	5.16	38.89	12.70	5.56	6.35	4.76	5.56	7.14	12.70	6.99	3.97	7.94	2.79	7.62	5.56	12.70	14.22	9.53	7.14	5.28	30
1 C	680.4	3.30	5.16	12.70	12.70	5.56	6.35	4.76	5.56	7.14	12.70	...	...	...	...	...	...	...	...	9.53	7.14	5.28	30
1 D	680.4	3.30	5.16	38.89	12.70	5.56	6.35	4.76	5.56	7.14	12.70	...	...	...	...	...	...	...	...	9.53	7.14	5.28	30
2 A	975.2	3.99	5.16	12.70	14.29	5.56	8.33	4.76	5.56	7.94	12.70	8.33	4.76	7.94	2.79	11.11	5.56	12.70	15.88	9.53	8.33	7.14	30
2 B	975.2	3.99	5.16	38.89	14.29	5.56	8.33	4.76	5.56	7.94	12.70	8.33	4.76	7.94	2.79	12.70	5.56	12.70	17.46	9.53	8.33	7.14	30
2 C	975.2	3.99	5.16	12.70	14.29	5.56	8.33	4.76	5.56	7.94	12.70	a8.33	a4.76	...	...	...	...	...	...	9.53	8.33	7.14	30
2 D	975.2	3.99	5.16	38.89	14.29	5.56	8.33	4.76	5.56	7.94	12.70	...	...	...	...	...	...	...	...	9.53	8.33	7.14	30
3 A	1,361	4.70	5.95	12.70	15.88	7.14	9.92	5.56	6.35	9.53	15.88	9.92	6.35	8.73	2.79	15.88	6.35	15.88	20.64	11.51	9.92	7.94	28
3 B	1,361	4.70	5.95	34.93	15.88	7.14	9.92	5.56	6.35	10.32	15.88	9.92	6.35	8.73	2.79	15.88	6.35	15.88	20.64	11.51	9.92	7.94	28
3 C	1,361	4.70	5.95	12.70	15.88	7.14	9.92	5.56	6.35	9.53	15.88	a9.92	a6.35	...	...	...	...	...	...	11.51	9.92	7.94	28
3 D	1,361	4.70	5.95	34.93	15.88	7.14	9.92	5.56	6.35	10.32	15.88	...	...	...	...	...	...	...	...	11.51	9.92	7.94	28
4 A	1,814	5.41	6.73	12.70	17.46	8.73	10.72	6.35	7.14	12.70	17.46	10.72	6.35	11.11	5.16	15.88	7.14	17.46	22.23	12.70	11.11	9.53	26
4 B	1,814	5.41	6.73	31.75	17.46	8.73	10.72	6.35	7.14	12.70	17.46	10.72	6.35	11.11	5.16	15.88	7.14	17.46	22.23	12.70	11.11	9.53	26
4 C	1,814	5.41	6.73	12.70	17.46	8.73	10.72	6.35	7.14	12.70	17.46	...	...	...	...	...	...	...	...	12.70	11.11	9.53	26
4 D	1,814	5.41	6.73	31.75	17.46	8.73	10.72	6.35	7.14	12.70	17.46	...	...	...	...	...	...	...	...	12.70	11.11	9.53	26
5 A	2,608	6.50	7.94	12.70	19.05	7.94	11.91	7.14	7.94	14.29	19.05	11.91	7.14	14.29	5.16	15.88	7.94	19.05	22.23	13.49	12.30	11.11	24
5 B	2,608	6.50	7.94	31.75	19.05	7.94	11.91	7.14	7.94	14.29	19.05	11.91	7.14	14.29	5.16	15.88	7.94	19.05	22.23	13.49	12.30	11.11	24
5 C	2,608	6.50	7.94	12.70	19.05	7.94	11.91	7.14	7.94	14.29	19.05	...	...	...	...	...	...	...	...	13.49	12.30	11.11	24
5 D	2,608	6.50	7.94	31.75	19.05	7.94	11.91	7.14	7.94	14.29	19.05	...	...	...	...	...	...	...	...	13.49	12.30	11.11	24
6 A	3,810	8.08	9.53	12.70	22.23	7.94	12.70	8.33	9.53	15.88	22.23	12.70	7.94	14.29	6.75	14.29	9.53	22.23	22.23	15.88	15.08	11.91	22
6 B	3,810	8.08	9.53	28.58	22.23	7.94	12.70	8.33	9.53	15.88	22.23	12.70	7.94	14.29	6.75	14.29	9.53	22.23	22.23	15.88	15.08	11.91	22
6 C	3,810	8.08	9.53	12.70	22.23	b7.94	12.70	8.33	9.53	15.88	22.23	...	...	...	...	...	...	...	...	15.88	15.08	11.91	22
6 D	3,810	8.08	9.53	28.58	22.23	7.94	12.70	8.33	9.53	15.88	22.23	...	...	...	...	...	...	...	...	15.88	15.08	11.91	22

a When a turnbuckle has two eye ends with different size holes for the pin and cable, the two diameters are given.
b This turnbuckle is to be bored to receive pin on one end only.

NOTE.—In column marked "I. A. S. B. No." the letters used are for the following items: A, short fork and eye turnbuckle; B, long fork and eye turnbuckle; C, short double-eye turnbuckle; D, long double-eye turnbuckle.

3S15—Specifications for 7 x 19 Extra-Flexible Steel-Wire Cable

GENERAL.—1. (*a*) This specification covers the finish, material, and construction of high-strength steel wire cable composed of tinned-coated steel wires twisted concentrically around a tinned-steel wire center, thus forming a strand and such strands twisted concentrically around a central strand of the same construction forming a cable.

(*b*) The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2 The wire shall be manufactured of either I. A. S. B. Standard Steel No. 1065, No. 1070, or No. 1080, the compositions of which are listed below.

MANUFACTURE.—3. (*a*) The steel wires composing the individual strands of cable shall be laid concentrically around the center wire in one layer of 6 wires and another, or outer layer, of 12 wires with a left-hand (counter clockwise) pitch, the lay or pitch of both layers being of the same length; the cable itself shall be constructed by twisting 6 of these strands composed of 19 wires each around a seventh strand of the same construction and material with a right-hand (clockwise) pitch or lay of 6 to 8 times the diameter of the whole.

It is not to be understood that the strand composing this cable must necessarily be composed of wires of the same diameter.

(*b*) The steel from which the wires composing the cable are drawn shall be manufactured by the acid open-hearth process.

(*c*) Wires composing the cable shall be uniformly coated with pure tin to solder readily.

(*d*) Joints in wires in cable having a diameter of 0.187 (3/16) in. (4.76 mm.) and larger shall be brazed in a gas fire. In cable having a diameter of 0.156 (5/32) in. (3.97 mm.) or less, wires may be joined either by brazing or twisting at the manufacturer's convenience. Tucked in or welded joints are not permitted. No two joints in individual wires shall be closer to one another in the completed cable, than 30 ft. (9.14 m).

WORKMANSHIP AND FINISH.—4. Each length of cable is to be evenly laid and free from kinks, loose wires, or other irregularities. The cable shall remain in this condition when unwound from the reel or bent around a standard thimble, proper precautions being taken to secure the ends.

PHYSICAL PROPERTIES AND TESTS.—*Tensile Test.*—5. (*a*) A tensile test shall be made upon each individual reel of cable purchased of a size.

(*b*) Samples of cable for testing for tensile strength shall be no less than 24 in. (610 mm.) in length. In making tensile tests the distance between jaws of testing machine with sample in place and before test shall be not less than 10 in. (254 mm.).

(*c*) Samples for tensile test may be clamped in the jaws of the testing machine in the usual manner to facilitate testing, but in case of failure or dispute on individual tests, and at the request of the manufacturer, check tests shall be made by socketing the samples with pure zinc.

(*d*) Cable for use in the construction of aircraft shall meet the required breaking strength specified in the table.

Bend Test.—(*e*) One bend test is to be made on a sample cut from each reel of cable of a given size. Each sample must be bent once around its own diameter and straightened again at least 20 times in succession in the same direction of bending without any of the wires breaking.

Torsion Test.—(*f*) A torsion test is to be made on one wire from each sample of cable taken for tensile test. The wire is to be gripped by two vises 8 in. (203 mm.) apart; one vise shall be turned uniformly at as high a rate of speed as possible without perceptibly heating the wire. One vise shall have free axial movement in either direction.

(*g*) The number of complete turns which the wire shall stand is determined by the formula:

$$\text{Number of turns} = \frac{2.2}{\text{diameter in inches}} = \frac{55.9}{\text{diameter in millimeters}}$$

(*h*) Failure of one piece of wire to show full number of turns specified in the above torsion test shall not be considered cause for rejection, but in such case two additional tests shall be made on two more wires from the same sample of cable, and if both samples meet the requirements of the specification, the cable shall be accepted in this respect.

DIMENSIONS AND TOLERANCES.—6. There shall be no permissible variation in diameter below size. Cable having a diameter of 0.125 (⅛) to 0.187 (3/16) in. (3.18 to 4.76 mm.), inclusive, shall have a permissible variation of 10 per cent above size, and cable having a diameter of 0.218 (7/32) to 0.375 (⅜) in. (5.56 to 9.53 mm.), inclusive, shall have a permissible variation of 7 per cent above size.

DELIVERY, PACKING, AND SHIPPING.—7. (*a*) All cable shall be shipped on reels in lengths as specified on orders.

(*b*) The dimensions of reels for different lengths and sizes of cable shall conform to the table attached to this specification.

(*c*) A tinned or galvanized steel seal wire of approved design shall pass around no less than 3 convolutions of the cable on the reel and shall pass through a linen tag showing the name of the manufacturer, the size and length of cable on the reel, the order number or other distinguishing marks, and a record of the test for tensile strength. A lead seal impressed with the official stamp of the representative of the Government making the inspection shall secure the ends of this seal wire and furnish evidence of inspection and acceptance.

(*d*) The outer layers of cable on a reel ready for shipment shall be protected from mechanical injury in handling and transportation by an efficient covering of burlap.

CHEMICAL COMPOSITION OF STANDARD CARBON STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur maximum.
1065	0.60-0.70	0.50-0.70	0.040	0.045
1070	.65-.75	.50-.70	.040	.045
1080	.75-.90	.25-.50	.040	.045

TABLE OF WEIGHTS, SIZES, AND STRENGTH OF CABLE.

English Units.			Metric Units.		
Diameter, inches.	Minimum breaking strength, pounds.	Approximate weight, pounds per 100 feet	Diameter, millimeters.	Minimum breaking strength, kilograms.	Approximate weight, kilograms per 100 meters
0.375 (⅜)	14,400	26.45	9.525	6,532	39.36
.344 (11/32)	12,500	22.53	8.731	5,670	33.53
.312 (5/16)	9,800	17.71	7.938	4,445	26.35
.281 (9/32)	8,000	14.56	7.144	3,629	21.67
.250 (¼)	7,000	12.00	6.350	3,175	17.86
.218 (7/32)	5,600	9.50	5.556	2,540	14.14
.187 (3/16)	4,200	6.47	4.763	1,905	9.63
.156 (5/32)	2,800	4.44	3.969	1,270	6.61
.125 (⅛)	2,000	2.88	3.175	907	4.29

The Spruce Supply Better

Maj. Charles R. Sligh, of the equipment division of the Air Service, U. S. Army, while refusing to commit himself on a report from Portland, Ore., that only 2,000,000 ft. of spruce is being delivered, as against a monthly requirement of 10,000,000 ft., did say that he took a very optimistic view of the future of the supply, and that it is now very encouraging. He attributes the improvement very largely to the effective work of Russell Hawkins, who was sent to Portland as the representative of the equipment division, with instructions to get the spruce.

Some spruce is coming from Alaska and even a small quantity from the forests of North Carolina. Eastern spruce is just as good in quality as Pacific coast spruce, but as the trees are smaller it is difficult to get the long sticks. Reliance for airplane wood is not entirely on spruce, however, as it is being found that yellow fir, which is the trade name for the outer portion of the Douglas fir, is well suited for the purpose.

Stereoscopic Picture War Record

The Signal Corps plans to make a stereoscopic picture record of the war for educational purposes. It is hoped persons who have the necessary high grade matched lenses will make them available for this use by the Government. It is intended to make such sets of pictures of the present war available at cost.

The Photographic Division of the Signal Corps is prepared to buy matched pairs of Zeiss or Goerz lenses with focal lengths of from 5½ to 7 in., and matched pairs of wider angle lenses of from 4 to 4¾ in. focal length.

REELS FOR CABLE.

ENGLISH UNITS.

Diameter of strand or cable.	Diameter of head.	Traverse or distance between heads.	Diameter of bundle.	Diameter of arbor hole.	Diameter of head.	Traverse or distance between heads.	Diameter of bundle.	Diameter of arbor hole.	Diameter of head.	Traverse or distance between heads.	Diameter of bundle.	Diameter of arbor hole.	Diameter of head.	Traverse or distance between heads.	Diameter of bundle.	Diameter of arbor hole.
	1,000 feet.				3,000 feet.				5,000 feet.				10,000 feet.			
In.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
1/32	12	4	8	1⅛	12	4	8	1⅛	12	4	8	1⅛	16	4	10	1⅛
1/16	12	4	8	1⅛	12	4	8	1⅛	16	4	10	1⅛	16	7	12	1⅛
5/64	12	4	8	1⅛	16	4	10	1⅛	16	7	12	1⅛	16	10	8	1⅛
3/32	12	4	8	1⅛	16	4	10	1⅛	16	7	12	1⅛	16	10	8	1⅛
7/64	16	4	10	1⅛	16	7	12	1⅛	16	10	8	1⅛	18	10	8	1⅛
⅛	16	4	10	1⅛	16	7	12	1⅛	16	10	8	1⅛	24	10	10	1⅛
9/64	16	7	12	1⅛	16	10	8	1⅛	24	10	10	1⅛	24	16	10	2⅛
5/32	16	7	12	1⅛	16	10	8	1⅛	24	10	10	1⅛	24	16	10	2⅛
3/16	18	7	12	2⅛	18	10	8	2⅛	24	10	10	2⅛	24	16	10	2⅛
7/32	18	7	12	2⅛	18	10	8	2⅛	24	10	10	2⅛	32	20	16	3⅛
¼	18	10	10	2⅛	24	10	10	2⅛	32	18	16	2⅛	36	22	18	3⅛
5/16	18	10	10	2⅛	24	10	10	2⅛	32	18	16	2⅛	36	22	18	3⅛
11/32	18	10	8	2⅛	32	16	16	2⅛	32	20	16	3⅛	50	16	26	3⅛
⅜	18	10	8	2⅛	32	16	16	2⅛	32	20	16	3⅛	50	16	26	3⅛

METRIC UNITS.

	305 meters.				914 meters.				1,524 meters.				3,048 meters.			
mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
0.794	305	102	203	28.58	305	102	203	28.58	305	102	203	28.58	406	102	254	28.58
1.588	305	102	203	28.58	305	102	203	28.58	406	102	254	28.58	406	178	305	28.58
1.984	305	102	203	28.58	406	102	254	28.58	406	178	305	28.58	406	254	203	28.58
2.381	305	102	203	28.58	406	102	254	28.58	406	178	305	28.58	406	254	203	28.58
2.778	406	102	254	28.58	406	178	305	28.58	406	254	203	28.58	457	254	203	28.58
3.175	406	102	254	28.58	406	178	305	28.58	406	254	203	28.58	610	254	254	28.58
3.572	406	178	305	28.58	406	254	203	28.58	610	254	254	28.58	610	406	254	53.98
3.969	406	178	305	28.58	406	254	203	28.58	610	254	254	28.58	610	406	254	53.98
4.763	457	178	305	53.98	457	254	203	53.98	610	254	254	53.98	610	406	254	53.98
5.556	457	178	305	53.98	457	254	203	53.98	610	254	254	53.98	813	508	406	79.38
6.350	457	254	254	53.98	610	254	254	53.98	813	457	406	53.98	914	560	457	79.38
7.938	457	254	254	53.98	610	254	254	53.98	813	457	406	53.98	914	560	457	79.38
8.731	457	254	203	53.98	813	406	406	53.98	813	508	406	79.38	1,270	406	660	79.38
9.525	457	254	203	53.98	813	406	406	53.98	813	508	406	79.38	1,270	406	660	79.38

In making racks for the above reels allow a 4-in. or 102-mm. greater width than the traverse specified above.

Appropriation of $1,126,654,260 Asked for Aeronautics

Over one and an eighth billion dollars for aeronautics were asked for in the budget submitted to Congress on its opening day by the Secretary of the Treasury, in addition to the large sum separately listed for the pay of officers and enlisted men. The total requirements are divided as follows:

Army	*$1,032,294,260*
Navy	*94,000,000*
National Advisory Committee for Aeronautics	*260,000*
Post Office Department	*100,000*
Total	*$1,126,654,260*

Some of the larger estimates for the Aviation Section of the Army are: Aeronautical salaries and wages, $9,566,800, against an expenditure of $299,742.10 in 1917; lighter-than-air equipment, $8,171,000, against $279,388.27 expended in 1917; airplanes and seaplanes, $235,866,000, against $6,240,634.55 expended in 1917; spare parts and accessories, $47,173,200, against $752,930.96 expended in 1917; extra engines and spare parts, $553,289,120, against $1,367,110.95 expended in 1917; maintenance, upkeep and operation of aero squadrons, $20,950,000, against $1,249,120.62 expended in 1917; aero stations, $30,240,000; maintenance, repair, etc., of buildings in Europe and purchase of land, $25,827,000; aviation clothing equipment, $1,358,440; development of new types of airplanes and engines, $2,000,000, against an expenditure of $70,462.39 in 1917; schools of military aeronautics, $8,050,000; machine guns for airplanes, $77,475,000, and photographic equipment, materials, etc., $3,405,500.

Of the $94,000,000 asked for the Navy, $93,000,000 is for equipment, material, etc., in comparison with an expenditure of $5,075,069.79 in 1917.

Among the items asked for the National Advisory Committee for Aeronautics are $65,000 for a large wind-tunnel building and its equipment, and $14,000 for the purchase, maintenance and operation of an airplane, while $100,000 is asked for the Post Office Department for an experimental airplane service.

Below are given in detail the separate requests as printed in the budgets:

The Army

For expenses of the Signal Service of the Army, as follows: Purchase, equipment, and repair of field electric telegraphs, radio installations, signal equipments and stores, binocular glasses, telescopes, heliostats, and other necessary instruments, including necessary meteorological instruments for use on target ranges; motorcycles and motor-driven vehicles used for technical and official purposes; professional and scientific books of reference, pamphlets, periodicals, newspapers and maps, for use in the office of the Chief Signal Officer; war balloons and airships and accessories, including their maintenance and repair; telephone apparatus (inclusive of exchange service) and maintenance of the same; electrical installations and maintenance at military posts; fire-control and direction apparatus and material for Field Artillery; maintenance and repair of military lines and cables, including salaries of civilian employes, supplies, general repairs, reserved supplies, and other expenses connected with the duty of collecting and transmitting information for the Army by telegraph or otherwise (acts May 12, 1917, vol. 40, p. 42, sec. 1; June 15, 1917, vol. 40, p. 187, sec. 1; Oct. 6, 1917, vol. 40, p. 355, sec. 1). $1,138,240,314.77.[*]

Provided, however, That no more than $1,032,294,260 of the foregoing appropriation shall be used for the purchase, manufacture, maintenance, repair and operation of airships and other aerial machines, including instruments and appliances of every sort and description necessary for the operation, construction or equipment of all types of aircraft, including guns, armament, ammunition, and all necessary spare parts and equipment connected therewith; and all necessary buildings for equipment and personnel in the Aviation Section and for the purchase, maintenance, repair, and operation, through the Chief Signal Officer of the Army, of all motor-propelled passenger and equipment carrying vehicles which may be necessary for the Aviation Section of the Signal Corps.

And also, for the establishment, equipment, maintenance and operation of aviation stations, including (*a*) the acquisition of land, or any interest in land, with any buildings and improvements thereon, by purchase, lease, donation, condemnation, or otherwise: *Provided*, That by order of the President any unappropriated or reserved public lands may be reserved from entry, designated, and used for such aviation stations; (*b*) the improvement of such land by clearing, grading, draining, seeding, and otherwise making the same suitable for the purpose intended; (*c*) the construction, maintenance, and repair of permanent or temporary barracks, quarters, hospitals, mess houses, administration, instructional, and recreational buildings, hangars, magazines, storehouses, sheds, shops, garages, boathouses, docks, radio stations, laboratories, observation stations, and all other buildings and structures necessary or advisable; (*d*) procuring and introducing water, electric light and power, telephones, telegraph, and sewerage to aviation stations and buildings and structures thereon by the extension of existing systems or the creation of new systems and their maintenance, operation, and repair, installation of plumbing, electric fixtures, and telephones, fire apparatus and fire-alarm systems and the maintenance, operation and repair of all such systems, fixtures, and apparatus; (*e*) construction and repair of roads, walks, sea walls, breakwaters, bridges, and wharves, dredging, filling, and otherwise improving land and water sites; (*f*) purchase of stoves and other cooking and heating apparatus, kitchen and tableware, and furniture and equipment for kitchens, mess halls, offices, quarters, barracks, hospitals, and other buildings, screens, lockers, refrigerators, and all other necessary equipment; (*g*) purchase of gasoline, oil, fuel, and all supplies of every kind and character necessary or advisable for maintenance and operation of aviation stations, including electric light and power, telephones, water supply and sewerage service; (*h*) purchase and manufacture and installation of all kinds of machinery, tools, material, supplies, and equipment for construction, maintenance, and repair of aircraft, buildings, and improvements at aviation stations, or property or appliances used in connection with aviation.

And also, for the purchase or manufacture and issue of special clothing, wearing apparel, and similar equipment for aviation purposes.

And also, for the actual and necessary expenses of officers, enlisted men and civilian employes of the Army and authorized agents sent on special duty at home and abroad for aviation purposes, including observation and investigation of foreign military operations and organization, manufacture of aircraft, and engines; also special courses in foreign aviation schools and manufacturing establishments, to be paid upon certificates of the Secretary of War certifying that the expenditures are necessary for military purposes.

And also, for vocational training, including employment of necessary civilian instructors in important trades related to aviation, purchase of tools, equipment, materials, and machines required for such training, purchase of textbooks, books of reference, scientific and professional papers, periodicals and magazines, and instruments and material for theoretical and practical instruction at aviation schools and stations, and all other means to carry out the provisions of section 27 of the act approved June 3, 1916, authorizing, in addition to the military training of soldiers while in active service, means for securing educational and vocational training of a character to increase their military efficiency and enable them to return to civil life better equipped for industrial, commercial, and general business occupations.

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[*] The amount appropriated for the fiscal year ending June 30, 1918, was $39,067,756 and $640,000,000. [The Act of July 24, 1917 (40 Stat. p. 247, Sec. 10), appropriated $640,000,000 for "Increase for Aviation, Signal Corps."]

Also to pay such civilian employes as may be necessary, and for the payment of their traveling and other necessary expenses.

Provided, That hereafter mileage to officers in the Aviation Section of the Signal Corps and officers of the Officers' Reserve Corps of the Aviation Section of the Signal Corps traveling on duty in connection with the Aviation Service, shall be paid from the appropriation for the work in connection with which the travel is performed.

And also, for the payment of all expenses in connection with the development of suitable types of aviation engines, airplanes, and other aircraft appurtenances, including the cost of sample engines, airplanes, and appurtenances, cost of any patents and other rights therein, and costs of investigation, experimentation, and research in respect thereto.

And also, for the payment of all expenses in connection with the creation, expansion, acquisition, and development of plants, factories, and establishments for the manufacture of airplanes, aircraft, engines, and appurtenances, including provision for the purchase or lease of land with the buildings thereon, construction of permanent or temporary buildings for all purposes, purchase of machinery, tools, and employment of operatives, together with all administrative expenses necessary, the purchase and supply of raw and semifinished materials and of fuel and all other things necessary for creating and extending the production of airplanes, aircraft, engines, and all appurtenances.

And also, for creating, maintaining, and operating at technical schools and colleges courses of instruction for aviation students, including cost of instruction, equipment, and supplies necessary for instruction and subsistence of students while receiving such instruction.

Provided, That, subject to the approval of the Secretary of War, motor-propelled vehicles, airplanes, engines, parts thereof, and appurtenances may be exchanged in part payment for new equipment of the same or similar character to be used for the same purpose as those proposed to be exchanged.

Provided further, That during the present emergency, officers and enlisted men of foreign armies attached to the Aviation Section of the Signal Corps as instructors or inspectors when traveling in the United States on official business pertaining to the Aviation Section of the Signal Corps shall be authorized, from funds appropriated by this act, the same mileage and transportation allowances as are authorized for officers or enlisted men of the Regular Army.

AVIATION SECTION—AERONAUTICAL SALARIES

Employes.	Per	Rate.	Estimated, 1919. *Number.*	Expended, 1917. *Number.*
Salaries:				
Instructors in flying	annum	$5,400.00	4	1
Do	do.	5,200.00	4	1
Do	do.	4,800.00	32	8
Do	do.	4,200.00	24	6
Do	do	3,000.00	92	23
Do	do.	1,500.00	24	6
Do	do.	1,200.00	196	49
Do	do.	900.00	8	2
Instructors in ballooning	do.	4,800.00	4	1
Do	do.	4,000.00	4	1
Do	do.	3,600.00	4	1
Do	do.	2,400.00	4	1
Aeronautical mechanical engineer	do.	4,800.00	4	1
Do	do.	4,000.00	4	1
Do	do.	3,600.00	16	4
Do	do.	3,000.00	12	3
Do	do.	2,750.00	24	6
Do	do.	2,700.00	4	1
Do	do.	2,400.00	36	9
Do	do.	2,100.00	8	2
Do	do.	1,800.00	44	11
Do	do.	1,500.00	32	8
Do	do.	1,200.00	4	1
Do	do.	1,000.00	4	1
Do	do.	1,200.00	..	3
Inspectors of airplanes and airplane engines	do.	3,000.00	10	1
Do	do.	2,400.00	40	8
Do	do.	2,100.00	..	9
Do	do.	2,000.00	100	3
Do	do.	1,900.00	..	1
Do	do.	1,800.00	1,500	44
Do	do.	1,600.00	800	2
Do	do.	1,500.00	..	19
Do	do.	1,400.00	950	1
Do	do.	1,200.00	600	20
Factory inspectors	do.	2,000.00	75	..
Do	do.	1,800.00	60	..
Do	do.	1,400.00	140	..
Consulting engineer	do.	5,000.00	..	1
Do	do.	2,500.00	2	..
Accountant	annum.	2,400.00	6	..
Accountant	do.	2,400.00	6	..
Do	do.	1,800.00	10	1
Do	do.	1,600.00	10	..
Clerks	do.	2,000.00	8	..
Do	do.	1,600.00	10	1
Do	do.	1,400.00	20	3
Do	do.	1,300.00	..	4
Do	do.	1,200.00	100	15
Do	do.	1,080.00	..	1
Do	do.	1,020.00	..	1
Do	do.	1,000.00	150	41
Bookkeeper	do.	1,500.00	10	1
Do	do.	1,200.00	30	1
Draftsman	do.	1,800.00	10	1
Do	do.	1,400.00	25	1
Do	do.	1,200.00	25	2
Do	do.	1,000.00	10	2
Do	do.	900.00	10	1
Plant engineer	do.	3,000.00	5	..
Do	do.	2,000.00	5	..
Do	do.	1,420.00	..	1
Photographer	do.	1,400.00	5	..
Do	do.	1,200.00	5	..
Military storekeeper	do.	1,400.00	4	1
Do	do.	1,200.00	10	9
Production expert	do.	3,000.00	5	..
Do	do.	2,000.00	5	..
Do	do.	1,200.00	..	1
Electrical machinists	do.	1,200.00	20	1
Messenger	do.	720.00	120	1
Watchman	do.	720.00	90	1
Wages:				
Chief packer	do.	1,000.00	110	1
Packer	do.	840.00	60	2
Model makers	do.	1,400.00	5	..
Do	do.	1,000.00	10	..
Instrument maker	do.	1,800.00	6	..
Do	do.	1,600.00	..	1
Do	do.	1,400.00	10	..
Do	do.	1,200.00	10	..
Carpenter	do.	1,000.00	90	1
Chauffeur	do.	720.00	150	2
Janitor	do.	600.00	50	..
Laborers	do.	660.00	100	..
Skilled laborer	do.	720.00	50	..
Aviation mechanicians	do.	1,900.00	..	1
Do	do.	1,800.00	..	25
Do	do.	1,650.00	..	2
Do	do.	1,620.00	..	7
Do	do.	1,500.00	..	45
Do	do.	1,200.00	..	33
Do	do.	1,020.00	..	2
Do	do.	1,000.00	..	5
Do	do.	900.00	..	4
Salaries			$9,012,600.00	$239,793.68
Wages			544,200.00	59,948.42

OTHER OBJECTS OF EXPENDITURE

Lighter-than-air equipment	8,171,000.00	279,388.27
Airplanes and seaplanes	235,866,000.00	6,240,634.55
Spare parts and accessories	47,173,200.00	752,930.96
Extra engines and spare parts	553,289,120.00	1,367,110.95
Maintenance, upkeep and operation of aero squadrons	20,950,000.00	1,249,120.62
Aero stations, United States	20,400,000.00	....
Aero stations, Panama	5,420,000.00	....
Aero stations, Hawaii	4,420,000.00	....
Maintenance, repair, etc., buildings in Europe	9,127,000.00	....
Purchase of land	16,700,000.00	....
Warehouse and supply depots	5,595,000.00	....
Aviation clothing equipment	1,358,440.00	....
Expenses of officers, enlisted men, and civilians on special duty	67,200.00	....
Vocational training	120,000.00	....
Mileage to officers and traveling expenses of civilian employees	3,050,000.00	....
Development of new types of airplanes and engines	2,000,000.00	70,462.39
Schools of military aeronautics	8,050,000.00	....
Machine guns for airplanes	77,475,000.00	....
Photographic equipment, material, etc.	3,405,500.00	....
Contingent expenses, office equipment, etc.	100,000.00	....
Construction	....	3,061,293.77
Leasing of land	....	77,512.13
Reserve officers and men	....	400,000.00
Anemometers, barographs, aviators' garments and other special accessories	....	2,841.45
Miscellaneous	....	358,314.90
Total aviation	$1,032,294,260.00	$14,159,351.89

PAY OF OFFICERS AND MEN

In the budget, the pay for officers and men of the Aviation Section is included in that of the Signal Corps. The requests for Signal Corps pay appropriations follow:

SIGNAL CORPS

Pay of 11,941 officers	$27,619,533.00
Aviation increase, officers	10,030,800.00
Additional pay for length of service, officers	100,000.00
Pay of 153,945 enlisted men	60,606,607.05
Aviation increase, men	4,916,800.00
Additional pay for length of service, men	150,000.00
Total	$103,423,740.05

The Navy

For aviation, to be expended under the direction of the Secretary of the Navy for procuring, producing, constructing, operating, preserving, storing, and handling aircraft, establishment and maintenance of aircraft stations, including the acquisition of land by purchase, donation, or condemnation; and for experimental work in the development of aviation for naval purposes, $94,000,000: *Provided*, That the sum to be paid out of this appropriation under the direction of the Secretary of the Navy for drafting, clerical, inspection, and messenger service for aircraft stations shall not exceed $300,000 (acts Mar. 4, 1917, vol. 39, p. 1169, sec. 1; June 15, 1917, vol. 40, p. 203, sec. 1; Oct. 6, 1917, vol. 40, p. 369, sec. 1), $94,000,000.*

	Estimated, 1919.	Expended, 1917.
Wages	$1,000,000.00	$235,079.70
Equipment, material, etc.	93,000,000.00	5,075,069.79
Unexpended balance	....	14,322,850.51
Total	$94,000,000.00	$19,633,000.00

National Advisory Committee for Aeronautics

For scientific research, technical investigations, and special reports in the field of aeronautics, including the necessary laboratory and technical assistants; travelling expenses of members and employes; rent offices in the District of Columbia; office supplies, printing, and other miscellaneous expenses; equipment, maintenance and operation of research laboratory, and construction of additional buildings necessary in connection therewith; purchase, maintenance, operation, and exchange of necessary airplanes and one motor-propelled, passenger-carrying vehicle; clerks; draftsmen; personal services in the field and in the District of Columbia: *Provided*, That the sum to be paid out of this appropriation for clerical, drafting, watchmen and messenger service for the fiscal year ending June thirtieth, nineteen hundred and nineteen, shall not exceed $20,000; in all (acts Mar. 3, 1915, vol. 38, p. 930, sec. 1: Mar. 4, 1917, vol. 39, p. 1170, sec. 1; Oct. 6, 1917, vol. 40, p. 369, sec. 1); $260,000.**

Employees.	Rate per annum.	Estimated, 1919. No.	Expended, 1917. No.
Salaries:			
Assistant secretary	$2,500.00	1	....
Clerk	1,500.00	1	1
Stenographer	1,400.00	1	....
Stenographer	1,200.00	6	....
Do.	1,000.00	4	3
Technical assistants	2,500.00	2	....
Mechanical engineer	2,400.00	1	....
Junior mechanical engineer	1,800.00	1	....
Do.	1,500.00	1	....
Aeronautical engineering draftsman	2,000.00	2	1
Assistant physicists	1,800.00	2	....
Messenger, janitor and charwoman	$40.00-240.00	3	....
Wages:			
Patternmaker	1,400.00	1	....
Machinists	1,300.00	2	....
Salaries	......	36,000	3,779.17
Wages	......	4,000	....
OTHER OBJECTS OF EXPENDITURE			
Traveling expenses	......	4,000	2,389.82
Rent of offices	......	4,000	1,200.00
Supplies, printing and miscellaneous expenses	......	10,000	3,187.21
Scientific research, technical investigation and special reports	......	67,000	8,096.10
Construction of research laboratory	......	...	68,943.40
Equipment, maintenance and operation of laboratory	......	40,000	....
Large wind-tunnel building, including balance, motor and general equipment	......	65,000	....
Construction of additional buildings	......	15,000	....
Purchase, maintenance and operation of automobile	......	1,000	....
Purchase, maintenance and operation of airplane	......	14,000	....
		$260,000	$88,515.70

Post Office Department

In the appropriation requested by the Post Office Department, authorization is asked for the Postmaster General "to expend not exceeding $100,000 for the purchase, operation and maintenance of airplanes for an experimental airplane mail service between such points as he may desire."

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* The amount appropriated for the fiscal year ending June 30, 1918, was $61,133,000.

** For the fiscal year ending June 30, 1918, $107,000 was appropriated.

Annual Report of the Secretary of the Navy

The Secretary of the Navy has made public his annual report for the fiscal year ending June 30, 1917, including operations and recommendations to Dec. 1, 1917.

Secretary Daniels points out that the enormous expansion and development of the Naval Air Service dates from the passage of the Naval Act on Aug. 29, 1916. The appropriations for Naval Aviation Service July 1, 1916, have been $67,633,000. Up to that time naval aviation had been almost entirely in the experimental and development stage, during which every type of seaplane offered by any United States builder had been tried, but none had been found fully satisfactory by the Pensacola Flying School. The organization for aeronautics has been thoroughly overhauled and coordination of all activities needed in developing an adequate air service arranged for by delegating responsibility for its creation to the Chief of Naval Operations and Material Bureaus of the Navy Department.

The flying school at Pensacola was enlarged and reorganized and a supply of seaplanes constructed by a contractor in quantity of a type suitable for instruction and incorporating all known safety features, according to the design outlined by the department, while other builders were encouraged to develop improvements. The department is now able to purchase satisfactory school seaplanes from at least four builders and their supply is now considered adequate to meet the needs of all training stations. Men have also been sent to France, England and Canada for flying instruction.

This development has been badly handicapped by lack of a suitable high-powered engine; one builder developed a 200-hp. tractor seaplane, of which quantities were then supplied to coastal air stations. While high-grade engines of French design were put into production, they were not of sufficient power for naval work. Only recently has what appears to be the desired engine become available. This is the so-called "Liberty" engine developed by the Aircraft Board, which gives every promise of providing an adequate power plant for service type aircraft. The engine has been installed in a seaplane and in a flying boat and the preliminary tests have been quite satisfactory.

Referring to the flying boat Secretary Daniels states that for sea work, foreign opinion at the present time, as well as our own, strongly favors it. This type is an American conception and it is a satisfaction to be able to state that here, at least, American designs have been well to the front and that it is not necessary to copy foreign patterns in order to insure our aviators being supplied with the best, but that the present task of the department is to produce at the earliest practicable time the numbers of these boats needed and to improve the type still further to meet still better the needs of the service.

Speaking of the kite balloons he says that there has been quite a development of towing kite balloons during the year and that their operation in fair weather presents no great difficulty, but kites to date have proved unable to withstand storm conditions. Improved types of balloons and means for handling are being developed.

Airships or dirigibles of modern European type had never been constructed in the United States, he says, but a design of a coast-patrol type was prepared in the department and a number of units have been successfully completed by several companies. A training school for dirigible pilots was established in Ohio, and a number of officers have become skillful operators. Coastal dirigible stations are being established from Massachusetts to Panama.

The commission [a special board, headed by Admiral Helm] recommended a submarine and aviation base at Coco Solo Point, Colon Harbor, which is well toward completion. The aviation base on North Island, San Diego Harbor, for the joint use of the Army and Navy, will undoubtedly be the largest and most important on the west coast. The following bases have been established: Chatham, Mass.; Montauk Point, Long Island; Rockaway Beach, Long Island; Cape May, at the entrance to the Delaware; Hampton Roads, on the aviation site of the Hampton Roads Operating Base; Miami, Fla.; Pensacola, Fla.; Colon, Panama Canal, and North Island, San Diego, Cal.

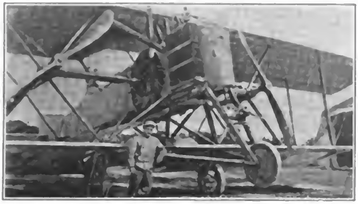
This commission also recommended Puget Sound Navy Yard as a location for a home base for submarines and an aviation station, and a submarine and aviation operating base at Ediz Hook, opposite Port Angeles, Wash., and one on the Columbia River.

As a part of the enormous expansion of aircraft production facilities the department undertook to build and equip a naval aircraft factory at the Philadelphia Navy Yard. Within ninety days from the date that the land was assigned, the factory was erected and the first flying boat keel laid.

Digest of the Foreign Aeronautical Press

Aeronautics (London), Oct. 31, 1917

The London Defenses and the Last Zeppelin Raid.—In the course of a discussion in Parliament on the last Zeppelin raid on England Sir George Cave made the following statement in behalf of the government: The raid on Friday night (Oct. 20) appears to have been carried out by ten or more Zeppelins. Of these five only reached the neighborhood of London, the remainder failing entirely to reach their objective, and leaving the country without causing material damage. Of the five Zeppelins which came near to London four failed to penetrate the London defenses, and did no damage. The remaining Zeppelin drifted over London with her engines shut off and dropped three bombs at intervals, causing loss of life. A number of our airplanes went up, but, owing to the atmospheric conditions, which were most unfavorable both for attack and defense, they were unable to bring raider to action. A number of the raiders drifted over France and four at least have been definitely accounted for by the French forces. Information as to the others is still awaited. The greatest possible credit is due to the French air men and the anti-aircraft artillery for their splendid performance, but in justice to the British anti-aircraft forces, it should be remembered that the airships they brought down in France were flying by daylight and at a much lower height than that which they kept whilst crossing this country. The government has already announced its intention to bomb German towns until an end is put to these cold-blooded attacks by Germany on the civil population of this country. Two such attacks have already been made, and the House may rest assured that the process will be continued until its purpose is attained.



French Gun-Spotter Carrying Radio Apparatus
Photo Central News Photo Service

Aeronautics (London), Nov. 7, 1917

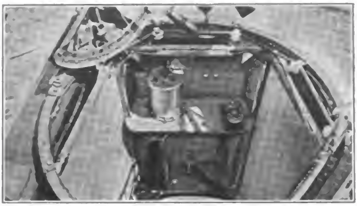
The British Air Service.—Sir Eric Geddes, First Lord of the Admiralty, in the course of a speech in the House of Commons on Oct. 31, made the following reference to the work of the Royal Naval Air Service:

"Since the outbreak of the war the personnel of the Royal Air Service increased from 700 to 41,000. The duties of the Royal Naval Air Service are varied, of great value, and of absorbing interest. Its great efficiency and gallantry in France are occasionally brought to public notice by reports of the bombing expeditions and otherwise. But any statement on the Navy would be incomplete without a tribute to the Royal Naval Air Service in operations over the sea. They are the terror of the submarine, and during one month the aircraft patrol around the British coast alone is more than five times the circumference of the earth.

"I think it may interest the House and instruct the public if I give some indication of what the Royal Naval Air Service alone has done in bombing behind the enemy lines in France. During September alone sixty-four raids were carried out on dockyards, naval depots, enemy aerodromes, and other objects of naval and military importance in Flanders behind the enemy lines. No less than 2,736 bombs were dropped by the Royal Naval Air Service alone, totalling 85 tons of explosives. The figures for October are not yet completely tabulated but are still greater. There is no doubt that these raids result in great material and moral damage, and on many occasions their effect is shown in the aerial photographs to be such as to hamper and restrict seriously the enemy naval, aerial, and military undertakings."

In the House of Lords, Earl Curzon paid on Oct. 29 the following tribute to the two branches of the British Air Service:

"I now come to the air service. When we are dealing with the Royal Flying Corps or either of the services, I deliberately say that nowhere in this country has the spirit of knight errantry been more conspicuously shown. When in August, 1914, 100 officers and 77 machines made their way to France, who could have foreseen that they would have developed into a great fleet of thousands of machines and tens of thousands of men. On the Western front in the first nine months of 1917 the men of the Royal Flying Corps brought down 876 enemy machines, they drove 759 out of action, 52 were brought down by anti-aircraft gunners; thousands of tons of explosives were dropped on aerodromes, bridges, railways, lines of communication, and even of marching regiments. Apart from offensive operations and activities of the air service, they are the eyes of the Army in the field. Then we must not forget the airmen at home, who have shattered the enemy's Zeppelins, and by their skill and bravery on many occasions have brought those great gasbags in flames to the ground. I sometimes think when Gothas are shrieking over London, and when the civil population are cowering in their cellars, we might give a thought to those brave men who are riding in the darkness above and risking their lives to save us from destruction. I include in the same tribute the officers and men of the Naval Air Service. There is no distinction between the two services. At the beginning of the war the personnel of the Naval Air Service was 800, and now it is 42,000. Its fleet in August, 1914, consisted of seven airships, 30 airplanes, and 34 seaplanes, whilst the number is now many thousands. The most effective branch of the service has been the naval squadron of Dunkirk, from whence it has bombed aerodromes and has diminished and at times stopped the aerial invasion of our country. These airmen have been in evidence in every theater. They have flown over Damascus, dropped bombs on Beyrout, destroyed buildings in Constantinople, and their flight to the Lake of Constance in the early part of the war and destruction of sheds there will be remembered."



The Radio Set, in the Forward Cockpit
Photo Central News Photo Service

The Aeroplane (London), Oct. 24, 1917

Germany's New Air Program.—According to Reuter's correspondent with the French Army, the French General Staff has gathered the following information regarding Germany's new air program: The Germans are well aware that some time next year the new American air squadron will come into action on the Western front, and they are already straining every nerve in order to be able to meet the Allied air offensive next spring.

The number of German battleplanes is to be doubled during the coming winter, and the airplanes and motor-building factories throughout Germany are enlarging their plants and obtaining reinforcements of labor to enable them to cope with the sudden influx of orders.

Switzerland is being laid under contribution. Two hundred and fifty Argus motors have been ordered from a firm in the Zurich district.

The Fokker firm, which is building fighting biplanes in great numbers, as well as a triplane remarkable for its speed and climbing powers, has taken over the great Berzina piano factories in Schwerin.

For bombing formations heavy three-seated machines are being built which can carry between 1700 and 1800 lb. weight of bombs. They have Mercédès 260 hp. motors, and when loaded can climb 12,000 ft. in 35 min.

In every type of flying machine the Germans are feverishly producing new models for long-distance scouting expeditions. The 1917 Rumpler, with 260 hp. Mercédès motor, is said to be the best machine.

They are also building a machine, made entirely of metal, to operate in conjunction with infantry on the battlefield. It has no great speed, and is a notably slow climber, and does not seem to be able to rise much above 10,000 feet.

The enemy is also using a new six-cylinder Maybach motor, developing 240 hp., which is lighter than the ordinary Mercédès, and gives greater speed in climbing.

A big German bombing machine which lately landed in Holland was fitted with an electrical installation, driven by the engine, for the purpose of warming the aviator.

During the six months from February to August twenty-nine important industrial establishments were added to the number of factories making airplanes or their accessories in Germany.

Simultaneously with this great increase in the output of machines, the Germans are looking everywhere for recruits for the flying service. Applications for transfer to the air service are now received from both infantry and engineers, instead of being restricted to cavalry, as was the case not long ago.

Applications are now dealt with in a month instead of two months, and there is no doubt that, in the course of the present year, the personnel of the German air service has been largely reinforced. Volunteers are wanted chiefly among the fighting planes, because it is chiefly among the fighting squadrons engaged on the battlefields that casualties occur, but a large number of officers are being trained as observers of observation planes.

Flying (London), Oct. 24, 1917

Torpedo Attack by Seaplanes.—At an early stage of the war the Germans made some experiments with a view to testing the possibility of launching Whitehead torpedoes from Zeppelins. A later development was the sinking of a British merchantman by a torpedo fired from a seaplane on the surface of the water. The practical difficulties to be overcome in designing apparatus which shall relegate to seaplanes the duty of aerial torpedo-boats are by no means insuperable. In its usual form the Whitehead torpedo is too heavy a weapon for any but the largest seaplanes to carry; thus a 21-in. torpedo weighs over a ton, while the 18-in. size, though somewhat lighter, scales as much as 12 cwt. Thus the number of 18-in. torpedoes which could be borne by a large seaplane could not be more than two in the case of machines laden with the supply of petrol necessary for a long oversea flight. Still, for use against cargo vessels a decidedly smaller explosive charge in the torpedo would have sufficient bursting power to sink the ship, and the ability of the seaplane to approach relatively close to its prey might lead to a marked decrease in the necessary propelling machinery in the torpedo. Thus as many as four small torpedoes of special type might be carried and, assuming that the airplane approaches to what, for a submarine, would be an impossibly close range, as many as half the torpedoes fired might be expected to strike the ship.

As far as general suitability for torpedo attack is concerned, the superiority of the submarine over the seaplane is indisputable, for, armed with its supply of torpedoes, it is prepared equally for attacks upon cargo vessels, transports, or battleships. The seaplane, on the other hand, can carry only a limited number of specially small torpedoes, and probably only a single one of sufficient size to imperil a battleship or cruiser protected by armor-plating. This, of course, raises the question of the possibility of, say, a squadron of airplanes attacking a fleet at sea. Such attack would be possible and successful only when based upon the element of surprise such as might be presented at night or in a mist hanging low over the sea. Given such conditions, it is conceivable that seaplanes would approach so close to the enemy as to fire a number of torpedoes with some measure of success and probable escape from the storm of shell-fire which their presence, once detected, would call forth. On the presence of other airplanes accompanying the fleet in seaplane-ships, the ultimate fate of the attacking aircraft must greatly depend.

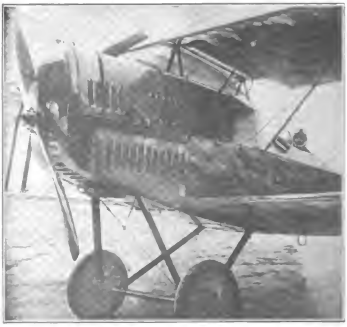
Flying (London), Oct. 31, 1917

Standardizing the Aero Engine.—In the fundamental design of a standardized engine technical skill of a higher grade than that found in the ordinary drawing-office routine is essential. Thus there must be no haphazard guessing at the unknown or untried, for the finished drawings will be expected to represent a machine closely fulfilling the requirements laid down by the flying services. The determination of the leading dimensions is based upon factors known empirically or formulated by theories which practice has confirmed; the questions of detail, for which the drawing-office will be held responsible, are settled from considerations of strength and ease of manufacture. How far the essential condition of provision for minor improvements at a later date can be allowed to vie with efficiency and reduction of labor costs is a matter for the designer's judgment.

The American Government has determined upon producing a super-engine; probably it will not be long before two or three sizes of this engine are under construction. For it is manifestly impossible for one engine to serve as the motive unit of all the varied types and sizes of airplanes which the air-war demands. It is possible, of course, to have one engine for the light scouting machine, to install two such motors in the heavier bombing machine and even three in the largest seaplanes and flying boats. But is this desirable? There are arguments against the employment of two air-screws in a machine, although, of course, all the largest craft are fitted with two engines—as, for instance, the Handley Page machine, which mounts two enormous engines.

The fulfilment of a diversity of purposes will be secured for the aero engine if its construction, even though standardized, is such as to permit of the combination of, say two unit engines to produce one large engine of twice the power. This principle is well known in many branches of mechanical engineering, and is important even if it involves certain structural difficulties. Probably, however, only a special crankshaft and crankcase are required for the duplication in tandem of two "unit" engines to form a double-power engine. The valuable feature of standardization, with nearly all the advantages of interchangeability, is thereby retained, and by mounting two of these "double" engines in one machine, each driving its own airscrew, we arrive at a system of propulsion suitable for the largest aircraft.

There is, thus, much to be said in favor of a standardized airplane engine produced upon a national basis, but lest, in our enthusiasm for the merits of this American policy, we lose sight of the disabilities of the system, be it remembered that engineering practice is based upon judicious compromise, and a compromise between results which are only, up to the present, of proved value.



Captain Laureati's 300-Hp. Sia Biplane

Photo Fiat *Passed by Committee on Public Information*

News of the Fortnight

The Aircraft Board Announced

On Dec. 7 Howard E. Coffin was nominated by President Wilson as chairman and Richard F. Howe as civilian member of the Aircraft Board. Mr. Coffin was chairman of the Aircraft Production Board which has been superseded by the Aircraft Board. Mr. Howe was formerly treasurer of the International Harvester Co. One civilian member is still to be appointed.

The other members of the Board who previously had been appointed are: Maj.-Gen. George O. Squier, Col. E. A. Deeds and Col. R. L. Montgomery, representing the Army; and Rear Admiral D. W. Taylor, Capt. N. E. Irwin and Lieut.-Com. Arthur K. Atkins, representing the Navy.

National Advisory Committee's Appointments

At a recent meeting of the National Advisory Committee for Aeronautics four new committees and a new subcommittee were named, and the committees on foreign representatives, and quarters, having completed their work, were discharged. The new committees are:

Civil Aerial Transport, Helicopter, or Direct-Lift Aircraft, Free Flight Tests, and Steel Construction for Aircraft. The new subcommittee on Light Alloys will be a branch of the Committee for Standardization and Investigation of Materials.

The personnel of all the committees is as follows:

Aero Torpedoes: Lieut-Commander J. H. Towers, U. S. N., chairman; Lieut.-Col. V. E. Clark, U. S. A.

Aircraft Communications: Dr. M. I. Pupin, Columbia University, chairman; Dr. Joseph S. Ames, Johns Hopkins University; Dr. S. W. Stratton, Director Bureau of Standards, and Dr. E. D. Ross, Bureau of Standards.

Airplane Mapping: Maj.-Gen. George O. Squier, U. S. A., chairman; Dr. Charles D. Walcott, secretary of the Smithsonian Institution, secretary; Capt. J. W. Bagley, E. R. C., and Carl G. Fisher.

Bibliography of Aeronautics: Prof. Charles F. Marvin, Chief U. S. S. Weather Bureau, chairman, and Dr. Joseph S. Ames.

Buildings, Laboratories, and Equipment: Dr. S. W. Stratton, chairman; Dr. Joseph S. Ames, Dr. W. F. Durand, Lieut.-Col. V. E. Clark, Signal Corps, U. S. A., and Lieut.-Commander J. H. Towers, U. S. N.

Civil Aerial Transport: Dr. W. F. Durand, chairman; Dr. S. W. Stratton, Prof. Charles F. Marvin, Lieut.-Col. V. E. Clark and Lieut.-Commander J. H. Towers, U. S. N.

Design, Construction, and Navigation of Aircraft: Maj.-Gen. George O. Squier, U. S. A., chairman; Dr. Joseph S. Ames; Lieut.-Commander J. H. Towers, U. S. N.; Lieut.-Col V. E. Clark, U. S. A.; Dr. A. F. Zahm, Navy Department, secretary; Frederick Alger; Dr. M. D. Hersey and Dr. J. H. Nelson.

Aeronautic Instruments: Dr. Joseph S. Ames, chairman; Commander C. T. Jewell, U. S. N.; Dr. M. D. Hersey; Maj. C. E. Mendenhall, Signal Corps, and Dr. Lyman Briggs.

Editorial: Dr. Joseph S. Ames, chairman; Dr. S. W. Stratton and Dr. W. F. Durand.

Free Flight Tests: Prof. John F. Hayford, chairman; Dr. W. F. Durand; Dr. S. W. Stratton; Lieut.-Col. V. E. Clark, U. S. A.; Prof. Alexander Klemin, Massachusetts Institute of Technology; Dr. Lyman Briggs; Dr. A. F. Zahm and Lieut. G. P. Thompson, R. F. C.

Government Relations: Dr. Charles D. Walcott, chairman, and Dr. S. W. Stratton.

Helicopter, or Direct-Lift Aircraft: Dr. W. F. Durand, chairman; Dr. M. I. Pupin; M. B. Sellers; E. B. Wilson and Dr. A. F. Zahm.

Nomenclature for Aeronautics: Dr. Joseph S. Ames, chairman; Dr. S. W. Stratton; Maj.-Gen. George O. Squier, U. S. A.; Capt. Mark L. Bristol, U. S. N., and Naval Constructor H. C. Richardson, U. S. N.

Power Plants: Dr. S. W. Stratton, chairman; Maj.-Gen. George O. Squier, U. S. A.; Dr. W. F. Durand; Lieut.-Commander J. H. Towers, U. S. N.; Dr. H. C. Dickinson, secretary; Maj. Joseph C. Riley, Signal Corps; Prof. E. C. Newcomb and Lieut.-Commander A. K. Atkins, U. S. N.

Relation of the Atmosphere to Aeronautics: Prof. Charles F. Marvin, chairman; Dr. J. S. Ames; Prof. J. F. Hayford; Lieut.-Commander J. H. Towers, U. S. N.; Lieut.-Col. T. DeWitt Milling, U. S. A.; Prof. J. C. Humphreys and Maj. Wm. R. Blair, Signal Corps.

Special Committee of Engineering Problems: Dr. W. F. Durand, chairman; Dr. S. W. Stratton, Dr. A. F. Zahm, Dr. H. C. Dickinson, Dr. Herbert Chase and G. C. Loening.

Standardization and Investigation of Materials: Dr. S. W. Stratton, chairman; Dr. Joseph S. Ames; Maj.-Gen. George O. Squier, U. S. A.; Dr. W. F. Durand; Prof. J. F. Hayford; Naval Constructor J. C. Hunsaker; Dr. J. H. Nelson and Dr. E. D. Walen.

Steel Construction for Aircraft: Dr. W. F. Durand, chairman; Dr. S. W. Stratton, Dr. A. F. Zahm, Dr. J. H. Nelson, F. G. Diffin, W. B. Stout, Jesse Coats, J. W. Smith and H. L. Whittemore.

Light Alloys: Dr. G. K. Burgess, chairman; Naval Constructor J. C. Hunsaker, C. M. Manly, E. Blough, Z. Jeffries and C. H. Mathewson.

Aircraft Board Against Aeronautical Shows

At the meeting of Dec. 4, at Washington, D. C., the new Aircraft Board confirmed the resolution passed by the late Aircraft Production Board on the subject of aircraft expositions, namely, that as a matter of general policy in view of the military situation, it does not encourage the holding of any aircraft expositions for the duration of the war.

S. A. E. Winter Meeting

"The Reasons Behind the Liberty Engine" has been scheduled as one of the leading engineering subjects to be considered by the Society of Automotive Engineers at its Winter meeting in New York on Jan. 10.

Maj. Jesse G. Vincent, one of the designers of the engine, will discuss the engineering reasons of the present twelve-cylinder Liberty engine.

A special discussion will follow, and will be opened by Lieut.-Col. V. E. Clark, U. S. A. His phase of the discussion will have to do with the military requirements of aviation engines.

Following Colonel Clark, Capt. Howard Marmon, who made an investigation of aviation engineering in Europe some months ago, and who is now engaged in aeronautical engineering work with Major Vincent at Dayton, Ohio, will compare the Liberty engine with European practice.

The discussion will be further carried out by H. M. Crane, engineer of the Simplex Co. His subject will have to do with adapting European engines to American methods of manufacture.

The Inter-Allied Conference Resolution

The Inter-Allied Conference, which recently convened in Paris, adopted the following resolution dealing with the aircraft programs of the Allies:

"The representatives of the Allied Nations examined the condition of their various war manufacturers and considered practical means of avoiding all duplication and directing the effort of each nation to the production of the things for which it was best fitted. In matters of first importance, an inter-allied committee was formed for carrying out the common programs, and decisions were arrived at."

DeClerq with Wright-Martin

A. E. DeClerq has resigned as metallurgical engineer for the Chalmers Motor Co. to join the Wright-Martin Aircraft Corp., New Brunswick, N. J., in a similar capacity.

C. B. Rose Called to Washington

C. B. Rose, vice-president and for many years chief engineer of the Velie Motors Corp., has been called to service in the Inspection Bureau of the Aviation Section at Washington.

Aeronautical Course at Philadelphia Y. M. C. A.

It has been announced that a free course in aeronautics will be established at the Central Branch, Y. M. C. A., Philadelphia, Pa., as part of the Government plans to train aviators. The course will be under the direction of trained experts and will be confined to teaching the theoretical end of aviation.

Wesley Joins Wright-Martin

George W. Wesley, who recently resigned as production head of the General Vehicle Co., has joined the Wright-Martin Aircraft Corp. in New York. His work with the Wright-Martin Corp. will also be along production lines.

Bills Pending Before Congress

Among the bills introduced in the first days of the present Congress was joint resolution 112 by Senator Owen of Oklahoma, creating an American Legion of Honor, and authorizing the President to grant decorations to be known as the Cross of Valor, and a decoration or medal for meritorious service, and permitting officers, employes and citizens of the United States to receive and wear decorations tendered to them by any of the nations now engaged in war with the present German Government.

Also joint resolution 164, by Representative Linthicum of Maryland, to permit "any soldier, sailor, marine or other person engaged in the service of the United States in the prosecution of the present war against Germany or any of her allies to accept decorations for valor and bravery from any of the nations allied with the United States in the prosecution of said war."

Also by Representative Hulbert of New York, permitting effective and able-bodied women between 18 and 35 years of age to enlist in the military forces of the United States, and providing that they may be commissioned as officers in the Aviation Section of the Signal Corps.

Also by Representative Sinnott, amending the act to provide revenue to defray war expenses so as to exempt military and naval officers and enlisted men from paying the war tax on tickets of admission to places of amusement.

Also by Representative Carter of Massachusetts, exempting military and naval officers and enlisted men from the payment of the war tax on railroad tickets.

Plans of the Civil Aerial Transport Committee

In a recent interview, Dr. W. F. Durand, chairman of the National Advisory Committee for Aeronautics, describes the future and plans of the new Civil Aerial Transport Committee. He said in part:

"The future of aviation is of vital importance even at the present time, because upon it depends very largely the future of the thousands of men now going into the air service, the millions or dollars allotted to it by Congress and by industry, and in general, the possibility of salvaging the present investment in aviation expressed in terms of human energy, skilled workmen, trained aviators, time and capital.

"Peace will find this country with an immense air capital on hand. This capital must be so conserved and directed that, if possible, not a man or a dollar will be wasted in the hiatus between war and peace. The situation at the termination of hostilities must be foreseen so far as humanly possible, and plans laid in advance in order that we may then avoid hasty and ill-advised measures.

"One of the most important of the many problems pressing for consideration is the human one of what is to become of our airmen. If, when peace comes, a few months are allowed to pass without new business, the industry which has been built up with such care would be seriously crippled. The vast army of workmen required under present conditions will be thrown out of employment and will be forced to seek opportunity elsewhere, thus adding to the industrial confusion which must be anticipated in the readjustment between war and peace.

"One of our problems will be to find means of minimizing the ill effects of such readjustments, possibly by having plans for peace planes for mails, coast guard, policing, and mapping, so up to date that when war orders stop the industry may change over with the minimum disturbance to the more permanent work ahead.

"The first and more obvious use of airplanes in the future lies in the delivery of mails. Already Congress has appropriated $100,000 for the initial steps in aerial mail delivery. The War Department has agreed, subject to Congressional approval, to turn over all planes no longer adaptable to military use to the Post Office as a beginning of its air service. In view of the numbers which may be so transferred later, it is essential to lay plans without delay, as is being done by the Post Office Department, for the specific routes, the aerodromes, quarters, personnel, etc.

"The possible achievements of airplanes in speed and distance seem to be limited only by the imagination. Instances of power and endurance indicate that commercial aviation is so close at hand that its problems must be foreseen. Among them are the 'rules of the air' as compared with the 'rules of the road at sea'; the ownership of the air above private property; questions of police and registration; the right of landing, which was recently denied by an American town; the supply of aerodromes at convenient intervals; the mapping out of air currents, etc. In the international field, questions will arise regarding the collection of customs on airplane freight which may be dropped anywhere within the country from the skies; also questions of 'ports of entry'; and the reciprocal use of landing places and aerodromes.

"In addition, extensive plans are already under way for coast guarding by airplanes and mapping the whole United States from the air. Vessels in distress at sea can be located and derelicts destroyed more easily through the air than through a heavy sea. The ten coastguard air stations recently authorized by Congress will undoubtedly spring into being as soon as men and planes are available. Likewise, the enormous task of mapping the whole of the United States, now carried out at such expense and under such difficulties, may be much more easily accomplished through the aid of aerial photography. These are some of the problems requiring early consideration."

Lanzius Aircraft Co.'s New Factory Site

The Lanzius Aircraft Co., 149 Broadway, New York, has acquired for a factory site and flying field a property containing 115 acres in Middletown, Pa.

The factory, it is announced, will be equipped to turn out 1,200 machines a year, and it is expected that equipment will be installed and ready for operation within a few months.

This company has under construction two scout machines, the principle of construction of which being the same as the machine first built by Mr. Lanzius and known as the "Lanzius Variable Angle of Incidence Airplane." The control for changing the angle of incidence is by worm gear, and requires no greater effort than is used in handling other surfaces. These machines will be powered with 8-cylinder Sturtevant 210 hp. engines.

Engle Aircraft Co. Organized

The Engle Aircraft Co., Niles, Ohio, has been organized for the purpose of manufacturing, buying, selling, assembling, repairing, storing, operating, and dealing in airplanes of all kinds and parts thereof and all articles pertaining thereto or to the operation thereof.

Its officers are: H. D. Baker, president: A. J. Engle, vice-president and production manager; G. S. Patterson, secretary and treasurer; directors: C. L. Bartshe, F. C. Case, Joel H. Fuller, Stephen L. Pierce, W. D. Sayle, and T. E. Thomas.

New Process for Plating Aluminum

United Smelting & Aluminum Co., Inc., New Haven, Conn., announces that it has a patented process for electroplating aluminum, which follows closely the standard process of electroplating other metals, and from which the same uniform results are obtainable as with other metals.

By this process aluminum may be plated with nickel, silver, copper, etc. The process is said to be equally applicable to pure aluminum in sheets, rods, wire, tubing, etc., and to aluminum alloyed with other metals, as in molded or die castings.

Glenn H. Curtiss Moves to Long Island

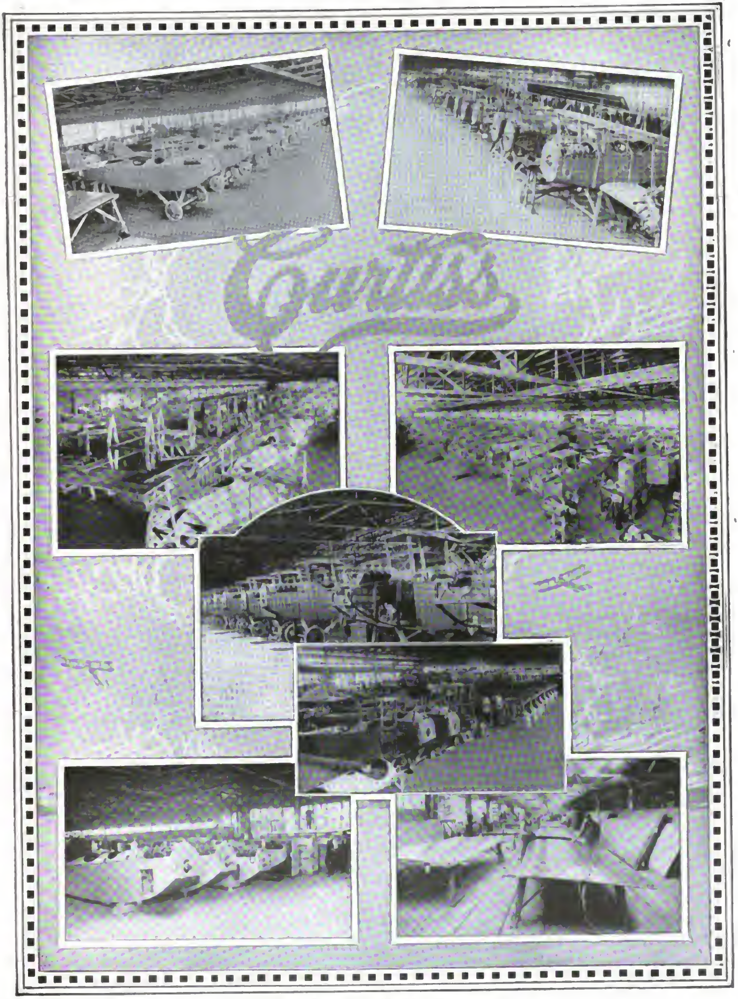
It has been announced that because of the removal of the experimental research and patent departments from the Curtiss Areoplane & Motor Corp., Buffalo, N. Y., to the Curtiss Engineering Corp., Garden City, N. Y., mail intended for Glenn H. Curtiss and for these departments should be addressed to the Curtiss Engineering Co. at the Garden City address.

C. D. Pruden Co. Opens New Offices

The C. D. Pruden Co., manufacturer of "Prudential" portable, galvanized steel buildings, underwriters' hollow metal windows, kalamein doors and windows, with main office and factory in Baltimore, Md., opened on Dec. 1 a general sales office for its products in rooms 806-807 Wallace Building, 56-58 Pine Street, New York City. The office will be in charge of Leigh Pruden, vice-president of the company.

Fahrig Metal Co.'s New Plant

The Fahrig Metal Co., maker of Fahrig anti-friction metal, which is used for bearings of truck, airplane and other high-grade gasoline engines, has opened another plant which will double the production of Fahrig metal, at 34 Commerce Street, New York.



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No. 3 Male, Long A-1524

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326 Short, Female
326 Long, Female
327 Long, Male
327 Long, Female
327 Short, Female
328 Long, Female
329 Long, Female

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THE Cleveland Tractor Company moved into this building 26 working days after date of order. The building was ordered October 11, 1917. The owner's acceptance is dated November 22. Notwithstanding 9 days of heavy rain, the building was ready 4 days ahead of time.

The building is an Austin Standard No. 2 30-day Factory-Building, 90 feet wide and, in this case, 200 feet long.

This was not a "rush" job. Austin Standard Buildings are ready in design and detail; basic costs are known and the essential materials are in stock ready for shipment.

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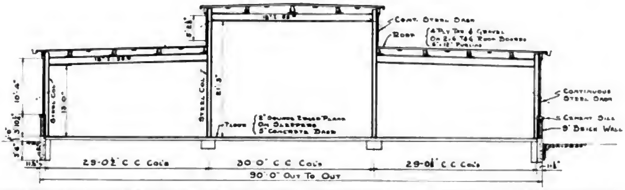
Washington	Bellvue Hotel	Main 2550
Pittsburgh	House Building	Court 1193
Philadelphia	Bulletin Building	Spruce 1291 Race 4017



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27th Aero Squadron

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Fort Worth, Texas.
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Nov. 9th, 1917.

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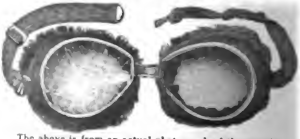
As they are of no further use to me, I am returning them to you as a proof of your advertising statement in regard to the unbreakable lenses.

I remain,

Very truly yours,
(Signed) JOHN M. HAYWARD.



The above is from an actual photograph of the goggles mentioned in Mr. Hayward's letter at the left

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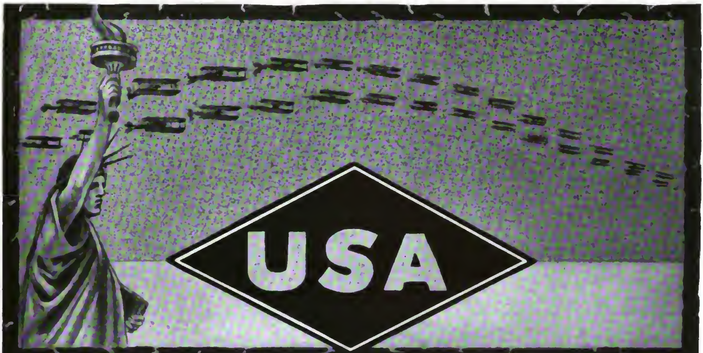

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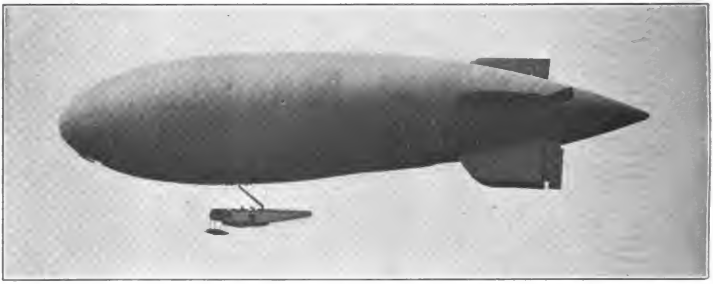

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An International Register of Airships, with a Compendiun of the Airship's Elementary Mechanics

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Passed by the Committee on Public Information

This volume is the result of a methodical investigation extending over a period of four years in the course of which many hundreds of English, French, Italian, German and Spanish publications and periodicals dealing with the present status as well as with the early history of airships have carefully been consulted and digested. It has thus become possible to gather under the cover of a handy reference-book a large amount of hitherto widely scattered information which, having mostly been published in foreign languages, was not immediately available to the English speaking public.

The information thus gathered is herewith presented in two parts; one being a compendium of the elementary principles underlying the construction and operation of airships, the other constituting an exhaustive, but tersely worded register of the world's airshipping which furnishes, whenever available, complete data for every airship of 500 cubic meters and over, that has been laid down since 1834. Smaller airships are listed only if they embody unusual features.

It has been attempted to furnish here the most up-to-date information regarding the gigantic fleet of airships built by Germany since the beginning of the Great War, a feature which may, in a certain measure, repay the reader for the utter lack of data on the Allies' recent airship constructions, which had to be withheld for military reasons. A revised and enlarged edition of *d'Orcy's Airship Manual,* in which all the airships built during the Great War will be listed and their features duly discussed, will be issued upon the termination of the war.

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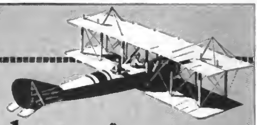

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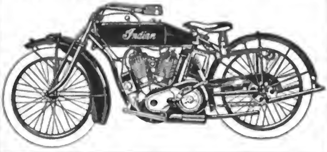

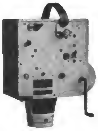

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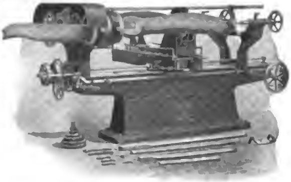

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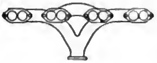

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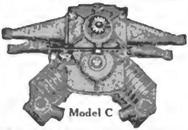
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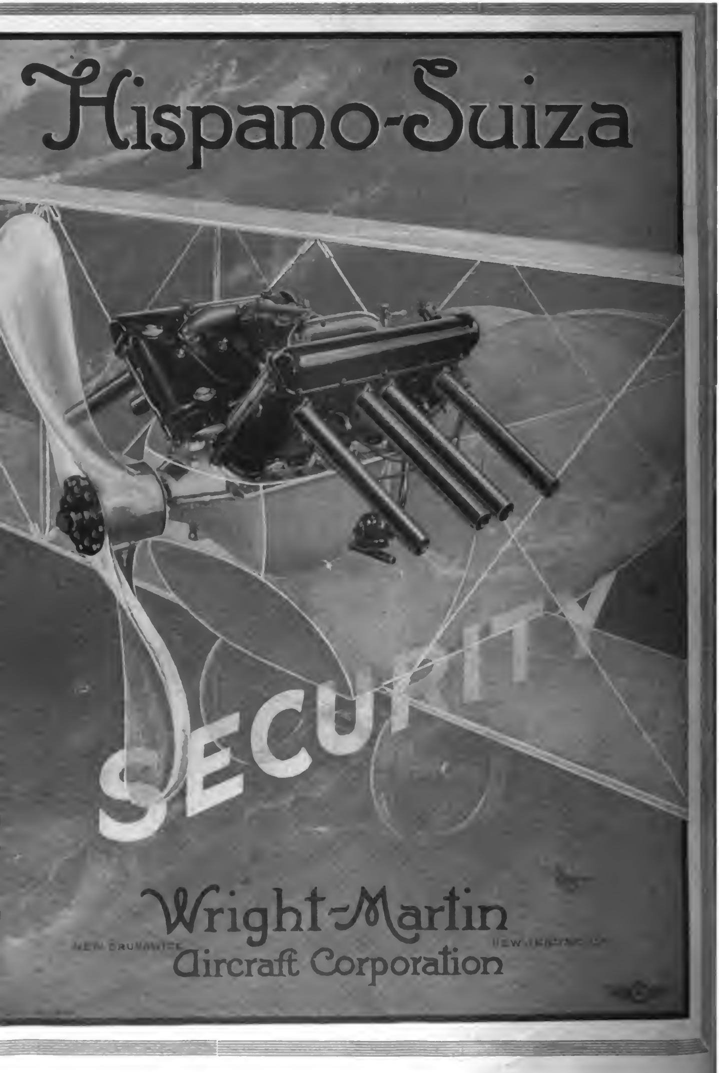
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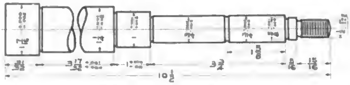

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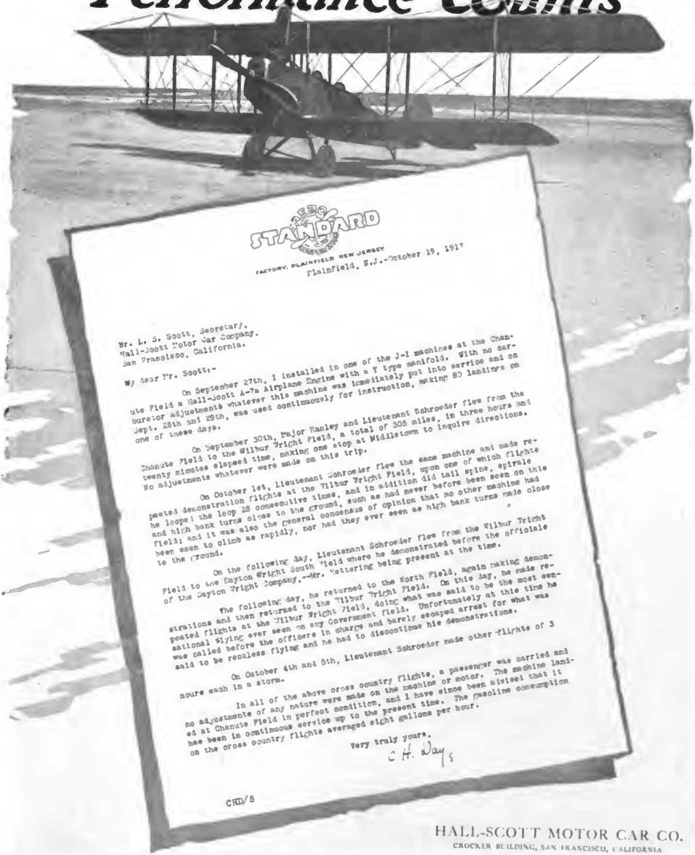

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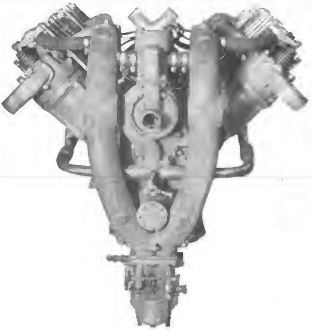

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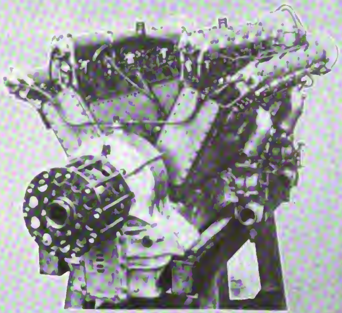

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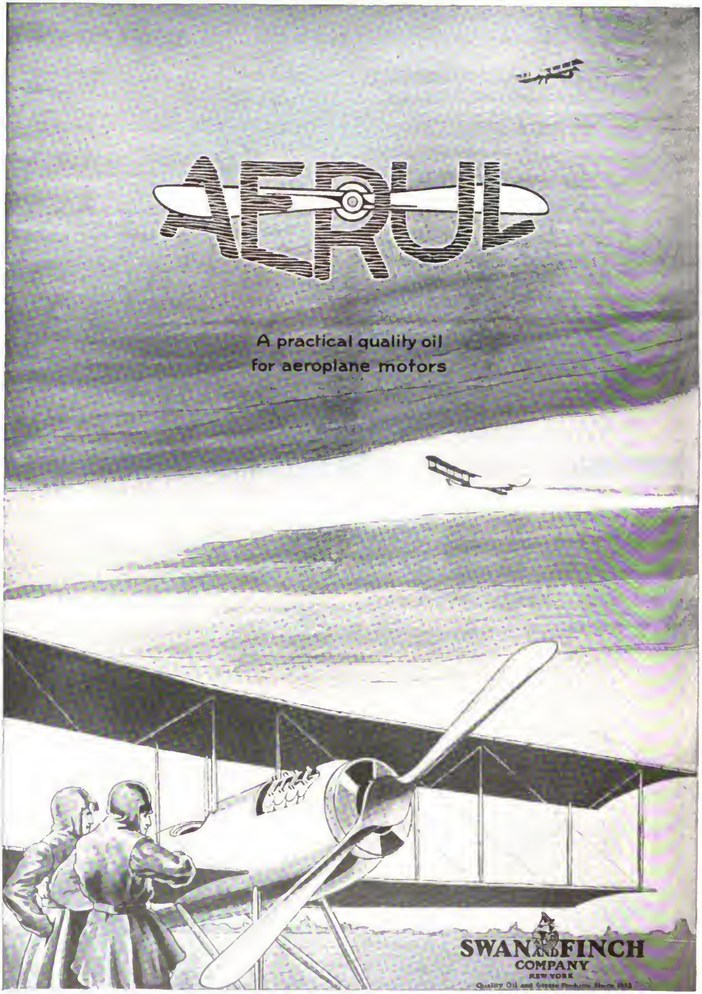
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AVIATION
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VOL. III. NO. 11

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Vol. III January 1, 1918 No. 11

Seaplane Float Construction

By Charles G. MacGregor

Curtiss Aeroplane and Motor Corp.

In the March 15, 1917, issue of Aviation and Aeronautical Engineering, an article by the writer dealt with the various forms of seaplane floats and their duties. To supplement this the following article will describe the construction of these floats, without going into the details too deeply, for the reason that each designer and builder has his own ideas as to how the minor points should be constructed. The following methods, however, have been found to be most practicable, and most of this construction has been accepted by the United States and other governments:

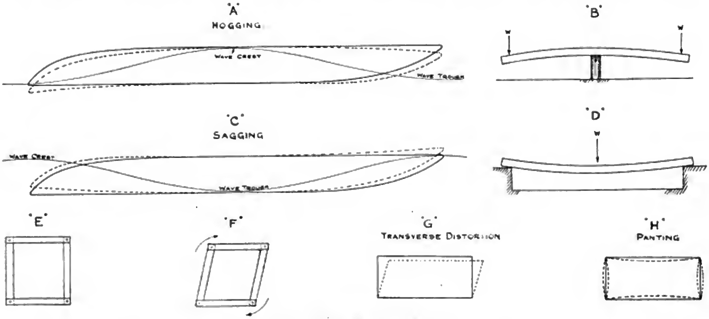


Fig. 1. Strains on the Float

Strains on the Float in a Seaway

Longitudinal Strains.—When a seaplane passes from calm water into a seaway, the float or floats are subjected to certain strains due to the action of the waves. Suppose the float is headed end on to a series of waves whose lengths from crest to crest, or from trough to trough, equal the length of the float, then these strains reach their maximum.

Let us consider the two extremes under the above conditions

(1) Suppose the float is supported in the middle on a wave crest and the ends unsupported by being in the trough; the consequence is, the ends will tend to droop relatively to the middle. This bending of the float is termed "Hogging" (Fig. 1-A). This condition, though only momentary, is comparable to a beam supported in the middle and weighted on the ends (Fig. 1-B). Under these circumstances the upper members of the structure of the float, such as the deck stringers, planking, etc., are in tension, and the lower members are in compression.

(2) Now let us consider the opposite extreme. As the waves travel along they reach a position where they support the two ends of the float, with the middle in the trough of the wave. In this condition the middle of the float will tend to droop relatively to the ends. This bending is termed "Sagging" (Fig. 1-C), and when in this condition the float can be likened to a beam supported at the ends and weighted in the middle (Fig. 1-D). Under these circumstances the lower members of the structure of the float, such as the keel, keelson, chine stringers, planking, etc., are in tension and the upper members are in compression.

Transverse Strains.—There are other strains tending to alter the transverse form of the float caused (1), by the seaplane rolling heavily; (2), by the seaplane making a skidding landing on the water, and (3), by the float being buried under a wave.

Take a square frame jointed at the corners (Fig. 1-E), and move it back and forward after the manner of a ship rolling (Fig. 1-F). The frame will distort, but will not break at the corners. This distortion is found in the float structure at the deck edge and chine corners (Fig. 1-G). Therefore, the construction at these points must be made very strong. The transverse bulkheads are most effective in preventing this racking.

The forward end of the float is subjected to severe blows from the waves, which tend to force the planking inward. This bending is termed "panting" and is taken care of by special stiffening, either by stringers or by transverse floors. Similarly the sides tend to work out and in, and the deck to sag by the weight of the water when buried in a wave (Fig. 1-H). The frames, floors and stringers resist this action and are therefore made sufficiently strong and are not spaced too far apart.

Construction

The construction of these floats must from the very nature of their work be very strong, and most important of all the lumber used must be of the very best that can be obtained, because each and every piece has to do its work almost to the limit of its strength; at the same time not a single ounce must be carried that is not absolutely required. Undoubtedly the quality and nature of the wood used in their construction at the present time leaves much to be desired. The builder is severely handicapped by being unable generally to get the most suitable wood. That obtained is often poor in quality, kiln-dried and improperly seasoned; delivery is uncertain, added to which the cost makes the purchase of the best almost prohibitive.

In the selection of lumber the greatest care is exercised as so much depends on the quality and strength of every part of each piece to do its allotted work under the most severe conditions. Lumber with knots and sap is never used, and great care is taken to see that none of the material is checked or has a twisted grain. These are probably the most important defects looked for.

As there are two distinct forms of floats, it will be better to refer to them separately because of the differences in their construction. The flat side and flat deck float is known as a "Flatback," and the rounded topside float is known as a "Roundback." There are, of course, many similarities in their construction, such as the keel, keelsons, stringers, etc. The principal difference in their construction is in the method of framing. Framing is the first step in the construction, consisting of the keel, keelsons, chine stringers, deck stringers, frames, floors and bulkheads; in short, it is the skeleton of the float before it is planked and covered.

For convenience in framing and planking, boats of the type of canoes, launches and small sailboats are built upside down, and the larger boats are built right side up. Generally the floats are built in two operations, first right side up, and when fully framed on the bottom and fully framed and planked on the topsides, they are turned over on their backs to finish the bottom planking. This method is found to be most convenient as the whole structure is very rigid when it is loosened from the building mould, and there is little chance of the float changing shape.

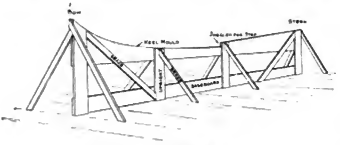


Fig. 2. Building Mould

Keel Mould.—This is the first erection in the process of building, and though not a part of the float it is nevertheless very important, as the whole hull is built on top of this, and great accuracy is necessary in getting it correct at first, because any mistakes made at this stage of the building will prove to be very costly if discovered after the framing is well advanced. The mould of the keel is usually built of ⅞-in. pine boards, with the upper edge cut to the form of the keel line. This is supported above the floor by uprights at a suitable height for working, and is supported transversely by braces nailed to the sides at their upper ends and to the floor at their lower ends. A simple form of building mould is illustrated in Fig. 2.

Keel.—When a boat is being built the first part of the structure to be laid on the keel blocks is the keel. This member is, broadly speaking, the backbone of the whole structure. The function of the keel is to assist in the stiffening of the hull longitudinally. Such is the case with the seaplane floats, although in some of the later ones the keel has been dispensed with entirely, and a center keelson used in its stead. Then again the keel and the keelson are used in conjunction as will be shown later on. When the seaplane is resting on the beach or deck of a ship, the weight of the whole machine is sometimes on the keel alone; one can, therefore, readily understand that this particular member must be very strong, indeed.

Several forms of keels are shown in Fig. 3. In *A*, *B*, and *E*, the under surfaces are rabbeted to receive the bottom planking edges. The bottom planking is nearly always built double skin, and sometimes two rabbets are cut in the keel, one for the inner skin and one for the outer skin, as shown in *A*. In *B* the keel is rabbeted for the inner skin only, the outer one running down and butting at the center line, or running across from chine to chine without a break at the keel. *C* and *D* are inside the planking, the underside being beveled to the form. The upper surface of *C* is cut out for the lower edge of the keelson and the edges are chamfered. *D* is not used with the center keelson. *E* is single rabbeted for both skins, the under surface projecting below the bottom planking from ½ to ⅝-in., thereby taking the place of the false keel. This is strong but not very good practice on account of the wear on this part of the float unless it is protected by a strip of brass screw fastened to the under surface. The keel is made in one continuous piece from stem to stern. In fact all stringers and planking used in the construction of these floats are each made in one continuous length when possible; as every piece is cut down to the minimum size to reduce weight, the addition of every butt, scarf and joint means the addition of weak points, more work and more weight.

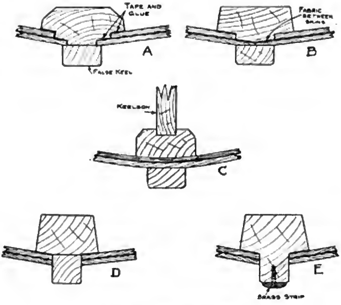


Fig. 3. Keel Sections

The keel is fastened temporarily and firmly to the keel mould by means of wood cleats which grip the upper edge of the keel and are screw fastened to the mould.

The materials used in the keel construction are white oak, ash, Canadian rock elm and mahogany. The two former are the most suited to this work; they are strong and will stand steam bending very well. Elm is very troublesome to work and most difficult to keep in shape, it twists and warps so much. Mahogany is satisfactory for keels with easy curves where no steam bending is required.

Scarfs.—Before proceeding any further with the construction we will look into the manner of making these joints or scarfs most commonly used in float construction.

Sometimes it is almost impossible to obtain certain lengths of lumber for planking or stringers; or it frequently happens that there is so much curvature in say a keelson, that to get it out of one piece would be well nigh impossible on account of the great width of board necessary, or on account of the cross grain at the ends. To overcome these difficulties it is necessary to make this particular part in two pieces. The joint of these two pieces is called a "scarf." Of these there are many varieties, but it is necessary here to mention only a few of those most commonly used in this class of work. These are illustrated in Fig. 4.

The fastenings are copper tacks, rivets and burrs, and brass wood screws. Where they come close together they are kept out of the same line of grain by staggering. This is necessary to avoid, where possible, the splitting of the wood.

A illustrates the short lap scarf, used mostly on planking. This is better made close to a frame, so that the frame can be used as part of the backing. The back block is riveted to the frame side, and the ends project over about ¼ in. so as to bear on the plank above and below the plank being scarfed. The forward edge of the after piece of the plank is always on the inside. The reason for this is that were it made with this edge outside, the rush of the water along the planking would get under and rip the whole plank out, if it projected a little above the surface of the planking. This edge is cut to a sharp edge and is covered by the backing block. The edge of the front portion is cut off square to not less than 1/16-in. and not more than one-fourth of the thickness of the planking. Screws are the best fastenings for this scarf because the planking at this point is very thin, and there is plenty of thickness behind into which the screws can be driven to secure a good hold. The surfaces are well covered with glue or varnish where they come in contact before fastening. *B* shows another method of joining plank ends. It is quite satisfactory though not so light as *A*. This is a square butt joint, backed by a slightly wider butt block than in *A*, wide enough on one side to take two rows of fastenings. *C* is a method adopted in scarfing keelsons, etc., where the pieces being scarfed are not less than ½ in. thick. The end of each piece is square as in *A*. *D* is used in scarfing stringers, etc. The two surfaces are joggled over each other, so that when they are riveted together and come under tension, they will hold, or "hook," and not slip. This relieves the fastenings from shear. In a case where the fastenings are not liable to come under shear, the plain scarf is sufficient, similar to *C*. It is sometimes advisable to scarf the pieces on edge, such as is done in wide stringers and keelsons. *E* illustrates this method. Slipping is prevented either by the means adopted in *D*, or by the use of a dowel pin. This pin is made of hardwood, is glued into one piece and tightly driven into a hole drilled in the other piece. The pieces are clamped and screw fastened and the ends and middle are strapped with light sheet copper. The heads of the nails securing the

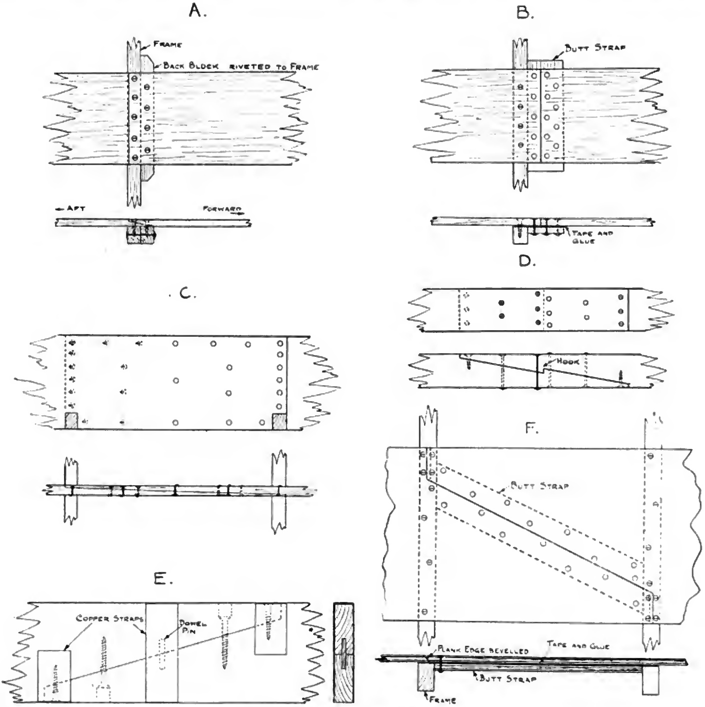


Fig. 4. Scarfs and Plank End Joints

copper are soldered, to prevent working loose.

In laminated construction the scarf is arranged irrespective of the grain. Care is taken to arrange the scarf, or butt, so that it does not all come within one frame space. *F* shows how this is accomplished. The butt block or strap is of the same thickness and material as the planking and is riveted to it. Tape and glue are laid between to ensure water-tightness. The edges of the planking where it butts are beveled to a slight angle instead of being made square.

Keelson.—The duty of this part is to assist the keel in stiffening the float longitudinally, and to strengthen the bottom to enable it to withstand the terrific impacts and pressure of the water. Sometimes only one center keelson is necessary, and then again one, two and even three side keelsons are used on each side of the keel or keelson between it and the chines (Fig. 5). The number used depends on the width of the bottom. The keelson is usually built of a thin board set up on its edge, the lower edge notched over the floors, and lightened by cutting holes or panels on each side between each floor (Figs. 5 and 6). The lower edge butting against the planking is held there by the wood screw plank fastenings. The upper edge is sometimes stiffened transversely by the addition of a cap strip. This piece is not necessary, provided the keelson is fairly thick, or if the unsupported span of the upper edge does not exceed 24 in. Sometimes stringers are used run along the inside of the bottom planking (Fig. 7). The keelsons are usually fitted after the bottom floors or framework are set up over the keel.

Where no keel is used, and the bottom planking runs across from chine to chine uninterruptedly, without any break at the centerline, the planking is screw fastened to the center keelson. When made thin and deep the following are used: white pine, white cedar, basswood, spruce, Port Orford cedar, yellow pine; when used as a stringer against the inside of the planking these are used: ash, white oak, mahogany, elm.

Floors.—The name given to this particular part of a boat is very confusing to one not familiar with boat or ship construction. These have nothing to do with decking or flooring directly, particularly so in the case of these floats. They are the cross frames or ribs of the bottom structure. Their duty is to assist the bulkheads in stiffening the bottom transversely. Each floor is made by either steam-bending it to form (Fig. 6), or by cutting it out of a solid piece to the desired form (Fig. 7). When cut out of the flat board they can be lightened by holes, and between these holes checking strips are glued and nailed

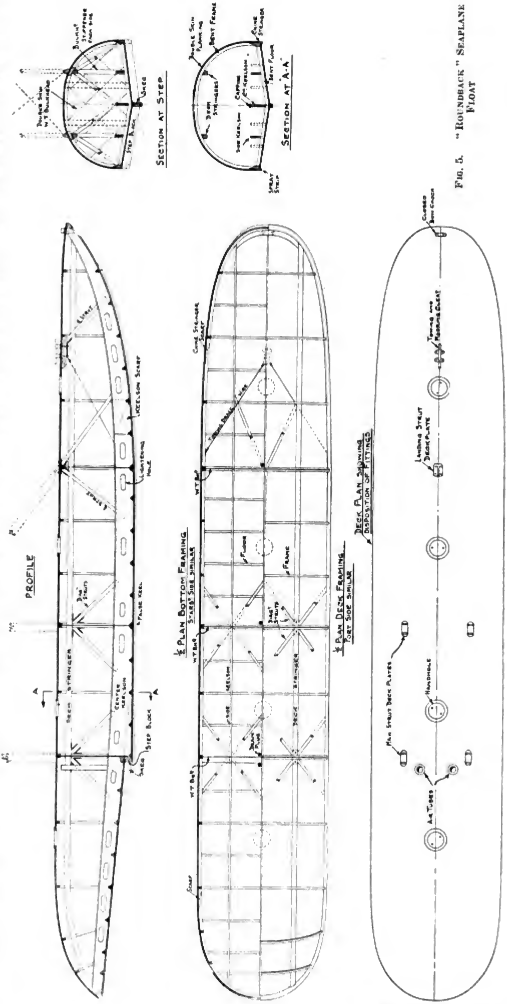


FIG. 5. "ROUNDBACK" SEAPLANE FLOAT

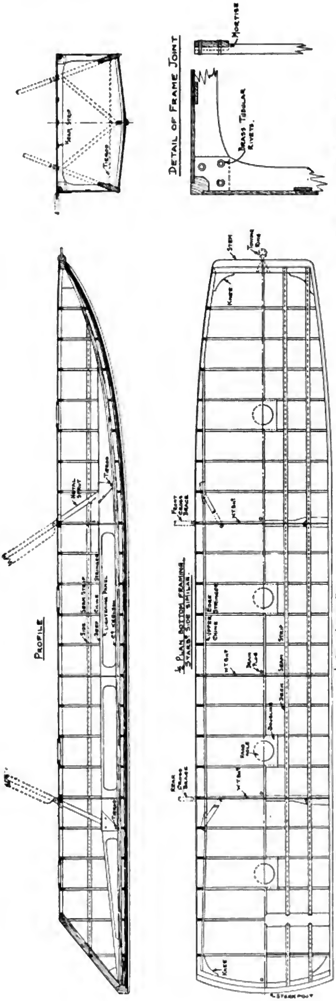


FIG. 6. "FLATBACK" FLOAT

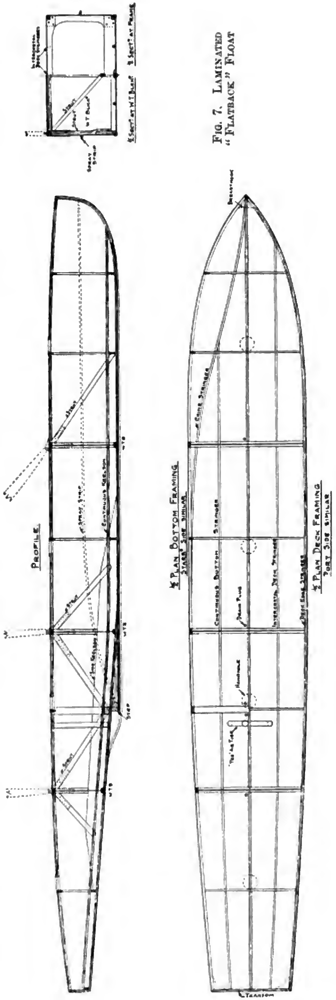


FIG. 7. LAMINATED "FLATBACK" FLOAT

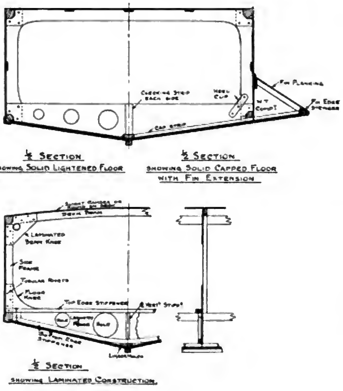
on each side (Fig. 8). These are necessary to prevent the wood from checking or splitting between the holes, which would undoubtedly happen when the wood dried out. Cap strips are sometimes fastened to the lower edge of the solid floors if made of pine or other soft wood (Fig. 8). This prevents splitting or checking of the floor and makes something firm into which to screw the plank fastenings. These cap strips are also used where an extension of the bottom is required by the side fins (Fig. 8). This illustration also shows the laminated floor construction. The upper edge has a stiffener fastened on with screws; the lower edge has a strip of ash or oak attached, to which the bottom planking is fastened, with the ends fastened to the side frames and chine stringers. A short vertical stiffener is fixed at the center line between the keel and the cross stiffener on the upper edge. The extremities are cut higher so as to form knees at the chines. The side frames are attached to these with hollow brass tubular rivets.

The materials used in floor construction are oak, ash, mahogany, Spanish cedar, white pine, spruce, Port Orford cedar, and sometimes basswood. Laminated wood is made in sheets of the following: alder, birch and Spanish cedar.

Stem.—This part of a boat is generally a vertical member, but in most of the floats built in this country it is a distinct departure from this type. It is just a continuation of the chine or deck stringers bent around to the desired curvature (Fig. 5); or it may take the form of a wood block, rabbeted for the planking ends, and into which the stringer ends are notched and fastened, reinforced in the corners by oak knees (Fig. 6). An additional piece is attached to the bent stem inside for the towing fittings. In the vertical stem construction (Fig. 7) the keel is continued right up to the deck, and riveted to the deck stringers with a breasthook or knee between.

The materials used in their construction are white oak, ash, Canadian rock elm for steam bending, and yellow pine and mahogany for the solid stem.

Sternpost.—These are similar to the stems in construction and material. Oak knees are used to brace the corners. Occasionally a transom or flat board stern is used by some builders (Fig. 7). This type of stern increases wind resistance and is not so light in construction as when the planking runs down to the sternpost without a break. The same applies to the stern illustrated in Fig. 7. An advantage claimed for the transom stern is that should the seaplane be afloat and drifting sternwards with the wind without having the sea anchor out, the water is not so liable to climb aboard, and thus tend to tip the machine over on its back.



½ Section showing Solid Lightened Floor

½ Section showing Solid Capped Floor with Fin Extension

½ Section showing Laminated Construction

Fig. 8

Chine Stringers.—The chine is the name given to the sharp corner at the junction of the bottom and sides of the float. Along this edge a stringer is run to support the edges of the side and bottom planking. This is called the chine stringer, and is made in various forms, the commonest of which are illustrated in Fig. 9. *A* is the simplest, but the plank edges are only protected by a thin copper strip. By cutting a rabbet as shown in the remainder of the sections, the construction is improved, although it is more costly and troublesome to make. A double rabbet as in *B* is not essential when the planking is so thin, so that it is seldom used in float construction. These stringers run in one piece along the sides to the stem and sternpost, and where a bent stem or sternpost is used, they are scarfed together just about where the straight of the sides ends, as shown on construction plan (Fig. 5). *C* shows the simple single rabetted chine stringer and *D* shows the built-up type. The inner portion is bevelled for the plank landing, and the outer piece is riveted to it between the plank edges. Should the chine get cut up by rubbing or striking any objects, this can easily be mended by moving this piece without disturbing the planking. *E* is a type of chine used in some roundbacks. It is deep and bevelled on the inside so that the frame heels can be riveted thereto. *F* shows another type of chine stringer made specially deep to which the main struts are attached; the frame heels are riveted to the outer side between it and the planking. This is difficult to build, but is very efficient in service. Limber or drain holes are cut between each frame so that water cannot lodge in the pockets formed between them.

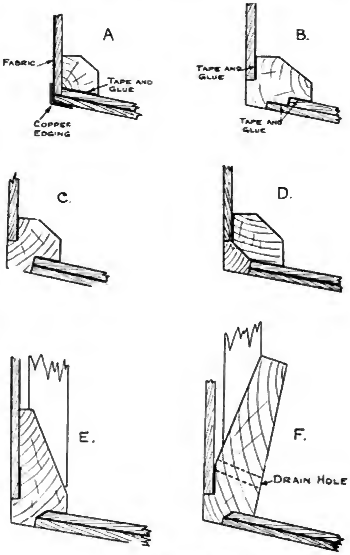


Fig. 9. Chine Stringer Sections

(To be continued)

Computation of Airplane Climb*

The altitude, at any time, of an airplane climbing at its maximum possible rate, is very nearly represented by a mathematical law similar to that for the rise of electric current in an inductive circuit. Thus if h be the altitude at a time, t and H the "ceiling" of the machine, we have the relation

$$h = H\left(1 - e^{-\frac{t}{T}}\right) \tag{1}$$

where e is the base of the natural or Napierian logarithms and T is a time, which, by analogy with the electrical case, may be called the "time constant" of the climb, being the time required by the altitude to become $1 - e^{-\frac{t}{T}}$ or .632 of its final value, *i.e.*, for the airplane to rise to a height equal to 0.632 of its ceiling.† Except that h and H and also t and T must be measured in the same units of height and time respectively, there is no restriction in this formula on the actual units used.

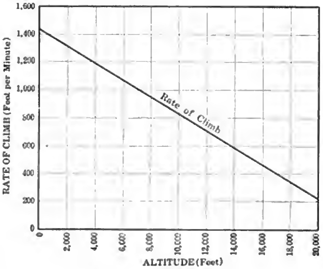
This being the case, it is possible to find expressions for the rate of climb at any time and at any altitude, and also an expression for the ceiling of the machine, which latter is quite simple. We will first show how to obtain such expressions from the equation already given, and afterward will give the application of these to a practical case.

The rate of climb is obtained by differentiating h with respect to t, and is

$$\frac{dh}{dt} = \frac{H}{T}\, e^{-\frac{t}{T}} \tag{2}$$

which is an equation giving the rate of climb in terms of the time, the ceiling, and the time constant.

By eliminating the exponential $e^{-\frac{t}{T}}$ from equations (1) and (2), we obtain an equation giving the rate of climb in terms of the altitude, the ceiling, and the time constant. This equation is



Rate of Climb Chart

$$\frac{dh}{dt} = \frac{H}{T}\left(1 - \frac{h}{H}\right) = \frac{H - h}{T},$$

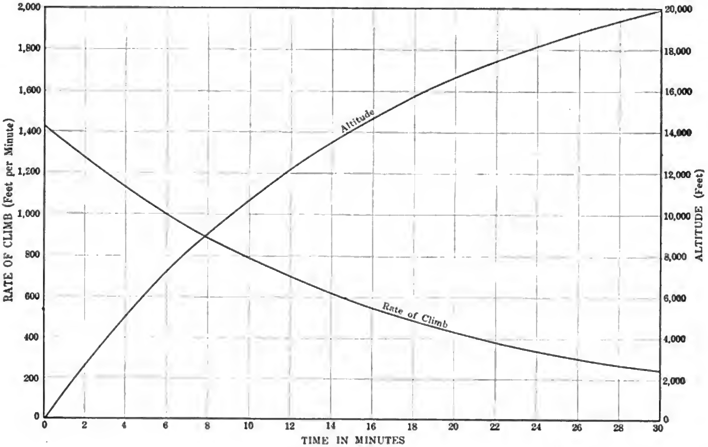
and shows that rate of climb plotted against altitude in a straight line. If we call rate of climb r we have

$$rT = H - h$$

or

$$\frac{h}{H} + \frac{r}{H/T} = 1 \tag{3}$$

which equation shows that when r is plotted against h, the intercept (H) of the straight line on the altitude axis is the ceiling of the machine (where rate of climb $r = o$) and the intercept $\left(\frac{H}{T}\right)$ on the rate of climb axis is the initial rate of climb, (*i. e.*, rate of climb when $h = o$).



Climb Chart

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* From *Flight* (London).

† The time required to rise to the ceiling is mathematically infinite.

The simple expression for the ceiling of a machine is obtained as follows:

After any time t from the start let the observed altitude of the airplane be h_1, and after a time $2t$ let it be h_2. Then we have

$$h_1 = H\left(1 - e^{-\frac{t}{T}}\right)$$

$$h_2 = H\left(1 - e^{-\frac{2t}{T}}\right)$$

Let us write X for the exponential $e^{-\frac{t}{T}}$ for convenience, then:

$$h_1 = H\ (1 - X)$$
$$h_2 = H\ (1 - X^2)$$

whence by division $\frac{h_2}{h_1} = 1 + X$

but since $\frac{h_1}{H} = 1 - X$

$$\therefore \frac{h_1}{H} = 2 - \frac{h_2}{h_1}$$

and $H = \dfrac{h_1}{2 - \dfrac{h_2}{h_1}}$

which gives the ceiling of the machine in terms of the altitude h_1 at time t and the altitude h_2 at time $2t$. (Note that t may be any time whatever during the climb.) So all we require, to calculate the ceiling of a machine, is the altitude after any time, and the altitude after double that time.

We will now illustrate the foregoing analysis by a practical example. Observations of a certain airplane on a climb test showed the altitude to be related to the time after start according to the following table:

Time (minutes)—	0	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5
Altitude (feet)—	0	3300	6150	8730	10760	12610	14190	15530	16650	17600

The ceiling of the machine may be calculated right away taking h_1 as 10760 ft. after 10 minutes and h_2 as 16650 ft. after 20 minutes. We have

$$H = \frac{10760}{2 - \frac{16650}{10760}}$$

$$= \frac{10760}{\cdot 4526} = 23{,}770 \text{ feet}$$

We may next calculate T, the time constant. The value of the exponential (which we called X for short) is (when $t = 10$ minutes)

$$X = \frac{h_2}{h_1} - 1 = \cdot 5474.$$

hence $-\frac{10}{T} = \log e\ \cdot 5474$

$$= 2\cdot 3026 \log_{10} \cdot 5474.$$

whence $T = \dfrac{10}{2\cdot 3026 \times \cdot 2617} = 16\cdot 60$ minutes.

The initial rate of climb

$$= \frac{\text{ceiling}}{\text{time constant}} = \frac{23770}{16\cdot 60}$$

$$= 1432 \text{ feet per minute.}$$

Having calculated the constants of the climb, we may now write down the equations for the altitude at any time, the rate of climb at any time, and the rate of climb at any autitude. They are respectively:—

$$h = 23770\left(1 - e^{-\frac{t}{16\cdot 60}}\right)$$

$$r = 1432\, e^{-\frac{t}{16\cdot 60}}$$

and $r = \dfrac{23770 - h}{16\cdot 60}.$

From the first two equations the altitude and rate of climb at any time t are calculable and the figures for the altitude are found to agree closely with the table already given, so far as this table goes. We give below a table calculated from these two equations, also a table showing rate of climb at various altitudes. The results are also plotted in the accompanying curves.

Time (minutes)—	0	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0	27.5	30.0
Altitude (feet)—	0	3320	6180	8640	10760	12575	14140	15485	16645	17640	18500	19240	19870
Rate of Climb (feet per minute)—	1432	1232	1060	911	784	674	580	499	429	369	318	273	235

Altitude (feet)—	0	2000	4000	6000	8000	10000	12000	14000	16000	18000	20000
Rate of Climb (feet per minute)—	1432	1311	1191	1070	950	829	709	588	468	348	227

Book Reviews

"How to Fly," by Captain D. Gordon E. Re Vley. Paul Elder & Co., San Francisco, $1, 100 pp.

This attractive little book of pocket size, intended for the guidance of the prospective aviator, is written in clear and concise language by a practical pilot.

The author advocates the single system of training, which is practised principally in France, as against the dual control system. He contends—and the brilliant legion of French aviators appears to bear out his statement—that the pupil who learns to fly in a series of graduated flights on the field and over the field, after he has properly grasped the maneuver of the airplane, quickly develops a tendency to rely on his own ability rather than on the help of the instructor—a tendency likely to be bred by the dual training system.

It is obvious that a pupil trained with the single system becomes much more quickly self-reliant and efficient to counteract such eventualities as may occur to him in flight, because he has acquired his knowledge of atmospheric conditions by practical experience.

His theory, "Do not rush students through their training—give them from six to nine months of instruction. Haste makes waste, and the results cannot fail to justify the means" is quite self-explanatory, although the time limit given may appear somewhat excessive under wartime conditions.

The various phases of the single-training system, as well as the requirements for obtaining the pilot, expert aviator and R. M. A. certificates are dealt with in a simple yet comprehensive manner.

The Eyes of the Army and Navy, by Flight Lieut. Albert H. Munday, R. N. A. S. (Harper & Bros. 227 pp.; $2.00 in flexible leather, $1.50 in cloth.)

Mr. Munday has written from the standpoint of a practical aviator, and it is hard to imagine a work better suited to be used as a textbook by the embryo military or naval aviator. The book is impossible to review in a conventional fashion, as it is made up of more than a dozen almost unrelated parts, a chapter apiece being devoted to subjects so widely diverse as navigation, theory of flight, wireless telegraphy, meteorology, engines, and photography.

As might be expected, the most authoritatively treated subjects are those which relate most closely to the daily work of Mr. Munday as a service pilot. Artillery observation, the care of machines, and aerial fighting, for example, are discussed with a clarity and, so far as military exigencies and the Defense of the Realm Act permit, with a completeness which leaves nothing to be desired. The theory of flight is somewhat confused by the attempt to relate it to fundamental dynamical principles, involving a discussion of the air-flow about wings, the downward momentum imparted to the air, etc.

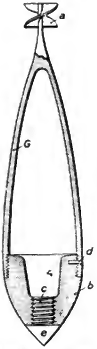
A particularly commendable feature in a book of this type is that it has been written with a minimum of formulæ.

Aircraft Bombs*

By Justin Lauvergne

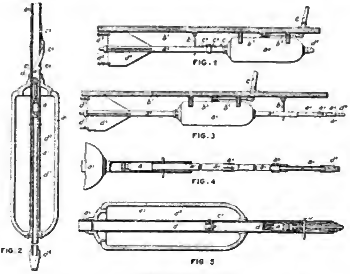
The missiles which were dropped from aircraft in the early part of the Great War were, for the greater part, bombs and grenades of obsolete types which had been formerly employed in field warfare. Their action was rather uncertain and their manipulation was often fraught with considerable danger.

A short time before the war broke out, the Vickers Works of England had, however, patented two types of aircraft bombs which were provided with a safety device that prevented their premature or accidental explosion. The destructive effect of these bombs also greatly exceeded that obtained with old-type missiles.



THE KUNKLER BOMB

a, Revolving Vane; *b*, Head Piece; *c*, Threaded Detonator Socket; *d*, Set Screw; *e*, Body of the Detonator; *g*, Body of the Bomb.

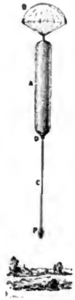


VICKERS PILOT BOMBS

Fig. 1.—The Bomb Suspended from the Airplane Body. Fig. 2.—Longitudinal Cross Section of the Body of the Bomb. Fig. 3.—Side Elevation of a Collapsible Model of Pilot Bomb. Fig. 4.—Longitudinal Cross Section of a Collapsible Pilot. Fig. 5.—Longitudinal Cross Section of the Body of the Bomb, with Collapsible Elements Compressed.

Figs. 1, 2.—*a*, Firing Charge; a_1, Pilot; a_2, Tail Piece; a_3, Shell of the Bomb; *b*, Locking Spindle; b_1, Airplane Body; b_2, Sliding Rod; b_3, Eye; *c*, Release Lever; c_1, Firing Pin; c_2, Spring Loaded Hammer; c_3, Spring; c_4, Stop; d_1, Tubular Firing Pin Guide; d_2, Point of Pilot Rod; *d*, Percussion Cap; d_3, Explosive Charge; d_4, Stabilizing Fins; d_5, Parachute Cords.

Figs. 3, 4, 5.—a_1, Pilot Rod; a_4, Longitudinal Cross Section of Collapsible Rod; a_5, Spring Loaded Claws; *b*, Spindle; c_1, Firing Pin; a_3, Shell of the Bomb; *a*, Firing Charge; d_2, Forward End of Tube a_1; d_3, Explosive Charge.

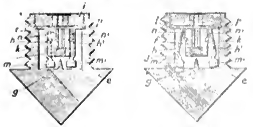


PILOT BOMB WITH PARACHUTE

A, Body of the Bomb; *B*, Parachute; *C*, Pilot Cord or Rod; *D*, Position of the Spring Which Is Tensioned by the Pilot; *P*, Pilot.

In the first type Vickers bomb, the firing charge is held remote from the explosive charge until after the launching, and means are provided to cause the bomb to explode at a previously determined distance from the ground or the target. For the latter purpose, the bomb is fitted with a "pilot" consisting of a metallic mass, which is suspended from the body of the bomb by a chain or a wire; the tension of this pilot cord is increased by a parachute, which slows down the bomb's vertical speed. The pilot cord is wound around a drum, which is connected with an aerial propeller, the latter being set in motion through the tension of the cord. When the cord is entirely unwound, the spring of the percussion needle is, therefore, held in place only by the weight of the pilot, so that as soon as the latter strikes its objective the spring is released and drives the needle into the percussion cap of the firing charge, which in its turn acts on the explosive charge. The height at which the bomb is made to explode over a target is, consequently, determined by the length of the pilot cord, and can thus be adjusted at will.

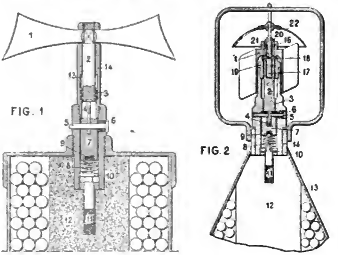
In another type, the mass of the pilot is composed of a cartridge with its percussion fuse and cap, and a fuse takes the place of the cord. On striking the target, the cartridge sets fire to the fuse, and this, in its turn, sets fire to the detonating charge. The latter object can also be attained by passing an electric current through the pilot, the current being furnished by accumulators housed in the bomb. The pilot cord is formed



THE KUNKLER DETONATOR

Fig. 1.—Before the Release. Fig. 2.—After the Release.

e, Head; *f*, Cap Holder; *g*, Firing Pin; hh_1, Springs; *i*, Plug; *j*, Percussion Cap; *k*, Groove. mm_1, Outer Springs; nn_1, Inner Springs, Clamping Cap Holder After the Outer Springs Are Unlocked



TWO MODELS OF THE MACHENBACH BOMB

Fig. 1.—*1*, Revolving Vane; *2-3*, Threaded Shaft; *4*, Extension Rod; *5*, Safety Gudgeon; *6*, Spiral Spring; *7*, Percussion Hammer; *8*, Percussion Spring; *9*, Percussion Cap; *10*, Percussion Needle; *11*, Firing Charge; *12*, Explosive Charge; *13-14*, Sleeve.

Fig. 2.—*13-14*, Sleeve; *7*, Percussion Hammer; *8*, Safety Spring; *9*, Percussion Cap; *10*, Percussion Pin; *11*, Firing Charge; *1*, Revolving Vane; *2*, Revolving Shaft; *4*, Pin; *5*, Safety Gudgeon; *6*, Spring; *16*, Lock Nut; *17*, Mobile Shaft; *19*, Guide Screw; *20*, Screw; *21*, Spring; *22*, Cap.

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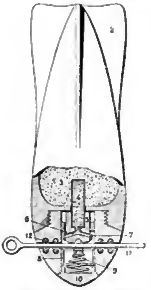
* Abstract from *Science et la Vie*.

of two conducting wires, the mass of the pilot closing the current on contact with the ground. The charge is set on fire either by a spark or by an electro-magnet actuating the percussion needle.

In another type of bomb, also manufactured by Vickers, the pilot consists of a rod, which is carried through the body of the bomb in the longitudinal axis; a tail piece carries in the rear the firing charge and stabilizing fins. The rod rests in a suitable guide, which is locked when the bomb is inactive, but through which it is permitted to slide when the lock is removed. The firing charge is thus kept far apart from the explosive charge, so that even an accidental discharge of the firing charge is not likely to endanger the lives of the crew.



THE PUTSCHER BOMB

1, Body of the Bomb; 2, Stabilizing Fin; 3, Explosive Charge; 4, Firing Charge; 5, Percussion Hammer; 6, Fuse Channels; 7, Firing Caps; 8, Friction Head; 9, Spring; 10, Plug; 11, Safety Spindle; 12, Ball Bearings.

The bomb is suspended underneath the airplane in a horizontal position. By operating the lever which releases the bomb the safety lock is automatically removed and, as the bomb gradually assumes a vertical position, the pilot rod slides forward, and carries the firing charge into the center of the explosive charge. A spring-loaded percussion needle then slides into a suitable aperture provided for in the tail piece of the bomb and is ready for action. When the pilot rod hits the ground, the impact makes it slide back in its guide; the firing charge is thus brought in contact with the needle and the explosion follows. To insure the free fall of the pilot rod when the bomb is released, the progress of the bomb is retarded by a parachute, while its course is steadied by stabilizing fins provided on the tail piece. In some models the pilot rod is composed of a number of telescoping tubes, which develop their whole length under the gravitational speed. The telescoping elements are held in place, after they have reached their full development, by suitable block-devices.

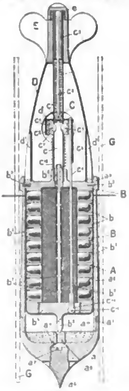


FIG. 1

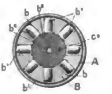


FIG. 2

THE BERGERY-DEROCLE REBOUNDING BOMB

Fig. 1.—Longitudinal Cross Section. Fig. 2.—Transverse Cross Section.

A. Casing; a. Head Piece; a_2. Tapered Part of Casing; a_3. Collar; a_{10}. Firing Charge; B. Hollow Cylinder; b. Projectile Ports; b_1. Projectiles; b_4. Projectile Retaining Sleeve; b_3. Catches; b_6. Plug; b_8. Firing Pin; b_6. Tube; b_7. Ports; C. Detonator; c. Detonator Guide; c_1. Firing Cap; c_2. Firing Pin Sliding in Tube c_1; c_3. Spring; c_{10}. Head of Rod; D. Shell Provided with Ports d; E. Stabilizing Fins Held in Position by Nut e; G. Launching Tube.

In the Kunkler bomb the safety device is based on the action of the centrifugal forces developed during the fall of the bomb. For this purpose the bomb is provided, at the rear, with an aerial propeller which imparts to the bomb a rotary motion. The firing charge is lodged in the head of the bomb, in a detonator, where it is held apart from the needle by means of two spring-loaded masses. As soon as the centrifugal force acquires a certain magnitude, the masses will overcome the force of the springs and move toward the periphery of the bomb, thus freeing the firing charge which is then held in place only by two clamps. On striking the ground the clamps will give way and drive the firing charge into the percussion needle.

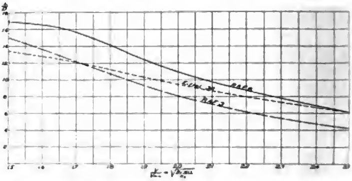
The bomb patented by Richard Machenbach and the Carbonit Sprengstoff A.G. of Germany is a missile fitted with rotating fins, which answer the double purpose of stabilizing its path and of unlocking the firing mechanism only after the bomb has travelled a certain distance, thus insuring the safety of its manipulants. Although this is no novel principle, the patentees claim for their bomb a greater simplicity and a more efficient control than hitherto attained. The firing mechanism is provided with a further safety device in so far as the aerial propeller which unlocks the firing pin is allowed to rotate only after a given time has elapsed from the moment the bomb is released. The working of this bomb, two types of which are shown, are obvious from the accompanying diagrams.

In the Putscher bomb the firing mechanism is actuated, like in the foregoing types, by direct impact. The fuse is set on fire by means of friction firing caps and the spring of the firing pin is blocked by a safety spindle, which must be removed before the release of the bomb.

The Bergery-Derocle bomb, which has been described in *Schuss und Waffe*, is of the rebounding type. This bomb consists of an external casing which is closed on its lower end and houses the body of the bomb proper. On striking the ground the case, which carries the firing charge, acts like a mortar and imparts to the bomb proper a force opposite to that of its trajectory, causing it to rebound upon striking the target. The external and internal portions of the bomb are kept in their relative position, up to the moment the impact occurs, by suitable catches. When the outer case strikes the ground its motion is annulled, but the bomb proper, having a considerable inertia, will tend to continue on its path. The force thus generated unlocks the catches and drives the bomb with its firing pin against the detonating charge contained in the outer case, which then shoots out the bomb proper like a projectile is fired from a gun.

A New Method of Plotting Wing Characteristics

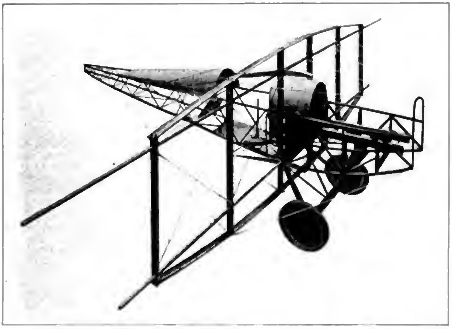
E. P. Warner suggests the plotting of L/D against $\frac{K_y \text{ max}}{K_y}$ and this is done for several sections in diagram. This is really the equivalent of plotting against the speed range ratio, since $K_y A V^2$ is always constant, and the speed of flight for any given value of K_y is equal to the speed corresponding to the maximum value of K_y (or, in general, the minimum speed

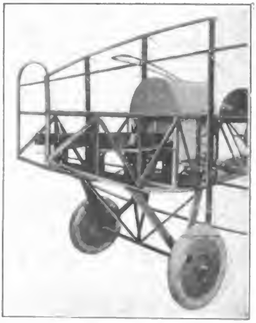


of the machine) multiplied by the square root of the ratio of the two lift coefficients under consideration, and it is, therefore, possible if a given landing speed is required and a known maximum to read directly the L/D obtainable at the maximum speed with a number of different sections, without any further effort than that required to find the ratio of the speeds in question.

The chart has not been carried out for values less than 1.5. Such an extension would only prove deceptive, as the minimum speed for a machine flying very nearly "tangent" is determined, not by the maximum value of K_y, but by the second intersection of the "power required" and "power available" curves.

The Lanzius Speed Scout


Skeleton of Lanzius Speed Scout


The Front Section

The Lanzius speed scout is, unlike most present day airplanes, a machine in which the incidence of the wings may be altered in flight at the will of the pilot.

Such an idea is not wholly new. Aeronautical investigators have predicted for years such a possibility. Indeed, Captain Duchêne in his celebrated work, "The Mechanics of the Airplane," dwelt with considerable force on this subject, and prophesied the adoption of the principle of variable incidence in future machines, to reduce or augment the drag which would give the pilot opportunity to check or increase his speed. He pointed out that existing difficulties "may be eventually overcome by the invention of the variable surface machine, which would permit a high speed to be maintained in normal flight while starting and landing could be accomplished at slow speed."

A machine based on this principle was produced in 1912 by Paul Schmitt, a Russian engineer living in France, and fully proved the correctness of the theory of variable incidence. This machine broke at the time several world's records for flights with five and more passengers. (A description of the Paul Schmitt airplane appeared in the Oct. 1, 1917 issue of Aviation and Aeronautical Engineering.)

George Lanzius, a Hollander, who was working on this very theory at that time and built models of the same as early as 1911, continually improved his designs until during the early part of 1917 he constructed a machine incorporating these features, which was successfully demonstrated in flight.

The outstanding features of this machine are:—

1—A cantilever frame, rigidly constructed to support the planes.

2—Planes pivoted in frame capable of being operated by pilot from 0 to 15 deg.

3—Ailerons pivoted on plane tips under the angle of about 15 deg., movable in opposite directions transverse to the planes.

4—A distinctive system of lateral control.

The machine is entirely built of steel, except for the wing frames. No wiring is used in the construction of the body, all members being joined by riveting. The cantilever frame is built up of streamlined tubing and the wings are pivoted on this frame at the will of the pilot by means of a fixed worm-gear.

The wings are built up in the usual way of wooden frames and are covered with fabric. The drift wires do not run, as herewith shown, to the radiator frame but are fastened to the upper longerons of the body. The skeleton of the machine, as illustrated, weighs complete 380 lb.

The under carriage is built up of streamlined V-struts and is equipped with resilient Ackerman wheels, which obviate the necessity for special shock absorbers. The control is of the stick type.

The characteristics of the Lanzius Speed Scout, as furnished by the manufacturer, are the following:

Span, upper plane	20 ft.
Span, lower plane	24 ft.
Chord, upper plane	4 ft.
Chord, lower plane	3 ft. 6 in.
Overall length	24 ft.
Overall height	8 ft. 6 in.
Weight, empty	1200 lb.
Weight, loaded	1800 lb.
Engine, Sturtevant	210 h.p.
High speed	140 m.p.h.
Low speed	40 m.p.h.
Fuel capacity	4 hrs.

Aeronautical Patents

ISSUED NOVEMBER 20, 1917

1,246,020—To Glenn H. Curtiss, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Landing gear for aircraft.

1,246,021—To Nelson W. Dalton, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Stream lined shock-absorber.

1,246,022—To Nelson W. Dalton, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Airplane motor support.

1,246,023—To Charles B. Kirkham, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Aerial propeller fastening.

1,246,024—To Henry Kleckler, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Airplane furniture.

1,246,025—To Henry Kleckler, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Dual interlocking control.

1,246,026—To Henry Kleckler, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Tail-skid clip.

1,246,027—To Henry Kleckler, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Airplane control surface.

1,246,028—To Henry Kleckler, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Airplane wing hinge.

1,246,874—To Everard Richard Calthrop, London, Eng. Parachute.

1,247,412—To Simon Lake, Milford, Conn. Flying machine.

ISSUED NOVEMBER 13, 1917

1,246,235—To Newton B. Converse, Fresno, Cal., assignor to himself as trustee. Balancing device for flying machines and the like.

1,246,311—To Arthur Timothy O'Leary, Butte, Mont. Airplane.

ISSUED DECEMBER 4, 1917.

1,248,545—To Hans J. M. Rasmussen, Chicago, Ill. Airplane.

ISSUED DECEMBER 11, 1917.

1,249,593—To Frank A. Bullington, Portland, Ore. Airplane.

1,249,829—To Frank J. Reynolds, Rantoul, Ill. Safety navigable marine parachute.

1,250,033—To Roy B. Scroggs, Eugene, Ore. Airplane.

International Aircraft Standards

(Continued from last issue)

2W1—Mill Specifications for Aircraft Douglas Fir

Region—1. All Douglas fir timber used in the production of this material shall have grown in the north Pacific coast timber region of western Oregon and Washington and near-by regions of British Columbia.

Timber—2. The trees used in the production of this lumber shall be preferably of the "young yellow fir" type and shall be in a healthy condition at the time of felling. Brashy lumber characteristic of old, overmature, or decadent yellow fir trees will not be accepted.

Logs—3. The logs from which the material is produced shall be preferably "butt" logs, and in no case shall "top" logs be used.

Grain—4. All grain shall be straight; that is, the angle of deviation from a line parallel with the edges shall not exceed 1 in 30 (1:30) on surfaces with diagonal grain and 1 in 20 (1:20) with spiral grain. Stock 4 in. and thicker may be flat grain and stock less than 4 in. thick shall be vertical grain.

Texture—5. (*a*) The wood shall be strong, tough, and elastic. Brashy pieces will not be accepted.

(*b*) The rate of growth of any piece shall not be less than 30 annual rings to each 3 in. (76.2 mm.) when measured in a radial direction on either end section through the zone of maximum growth. Furthermore, no single in. (25.4 mm.) shall have less than 8 annual growth rings.

Knots and Burls—6. (*a*) Not less than 90 per cent of the total footage of each shipment shall be free from knots of all kinds, and from burly, curly, gnarly, and irregular grain, on all four sides of each piece.

(*b*) In the pieces comprising the balance of the shipment (10 per cent or less) knots and burls or similar irregularities of grain and other defects will be allowed, provided that the buyer is able to obtain cuttings from each piece which are clear, sound, straight-grained, and not less than 5 in. (127 mm.) wide and 16 ft. (4.88 m.) long. Not more than 25 per cent of the total volume of each piece shall be discarded in sawing out cuttings.

Pitch Pockets—7. (*a*) One pitch seam or pocket not to exceed 2 in. (50.8 mm.) long or its equivalent in minor pockets (provided they are not in the same annual ring) will be allowed in either or both faces of each piece 16 to 31 ft. (4.88 to 9.45 m.) long and two such pockets or their equivalent in either or both faces of each piece 32 to 40 ft. (9.75 to 12.19 m.) long. Pieces shorter than 16 ft. (4.88 m.) and pieces narrower than 6 in. (152.4 mm.) shall be free from pitch pockets.

(*b*) Pieces having pitch pockets too large or too numerous to be allowed as defined in paragraph 7 (*a*) will be inspected in the same manner as for knots and burls as specified in paragraph 6 (*b*).

Sap—8. Bright sap will be allowed in any piece, provided it does not extend more than one-fourth the width of the piece or one-third its length.

Rot and Shake—9. All pieces shall be free from rot, shake, dote, red heart, purple heart, and all other forms of decay.

Tool Marks and Other Defects—10. Pieces must be free from picaroon holes, hook marks, and other defects caused by handling-tools, and equipment.

Wane—11. Wane will be allowed on occasional pieces, but in no case shall it exceed either one-fourth the thickness, one-eighth the width, or one-sixth the length of the piece.

Dimensions—12. Percentages of various thicknesses, widths, and lengths, and the respective percentages of flat and vertical grain stock to be supplied are subject to special arrangement between purchaser and contractor at the time prices are fixed.

Tolerances—13. (*a*) Thickness may be scant not to exceed one-eighth in. (3.18 mm.) on occasional pieces. If more than one-eighth inch (3.18 mm.) scant they will be accepted at contractor's option and tallied in the next inch class below.

(*b*) Widths may be scant not to exceed one-fourth inch (6.35 mm.) on occasional pieces. If scant more than one-fourth inch (6.35 mm.) they will be accepted at contractor's option and tallied in the next inch class below.

(*c*) Lengths may be scant not to exceed 2 in. (50.8 mm.) on occasional pieces. If scant more than 2 in. (50.8 mm.) they will be accepted at contractor's option and tallied in the next 1-ft. class below.

Loading—14. Shipment is to be loaded and covered in the manner prescribed by the purchaser.

3S22—Specifications for Mild Carbon Steel Tubes

General—1. The general specifications 1G1, shall form, according to their applicability, a part of these specifications.

Use.—2. These tubes are suitable for all parts not heavily stressed, such as trailing edges and elevators.

Material—3. The I. A. S. B. standard steel No. 1020 shall be used. The composition is as follows:

	Per cent.
Carbon	0.15-0.25
Manganese	.30- .60
Phosphorus, maximum	.045
Sulphur, maximum	.050

Manufacture—4. The tubes are to be of the cold-drawn, seamless type and are to be furnished annealed.

Any tube may be rejected at any time because of injurious defects or faults in the steel which are revealed by manufacturing operations, notwithstanding the fact that it has previously passed inspection. Such rejected material shall be returned to the manufacturer at the latter's expense. This clause shall not apply to materials fabricated after export.

Workmanship and Finish—5. The tubes are to be smooth, of the section specified, and within the permissible tolerances as to wall thickness, of uniform diameter, free from scale, dirt, specks, longitudinal seaming, lamination, grooving, and blistering, both internally and externally.

Physical Properties and Tests—6. The tubes shall have the following physical properties:

Tensile Test—(*a*)

Minimum tensile strength, 60,000 lb. per sq. in. (42.18 kg./mm.^{2}).

Minimum yield point, 36,000 lb. per sq. in (25.31 kg./mm.^{2}).

Minimum elongation, 25 per cent in 2 in. (50.8 mm.), or 10 per cent in 8 in. (203.2 mm.).

Crushing Test—(*b*) The test specimen shall be crushed endwise until the outside diameter is increased in one zone by 25 per cent, or until one complete fold is formed. The specimen shall stand this treatment without cracking.

Selection of Test Specimens—7. One test specimen for the tensile test shall be chosen from every 400 ft (121.9 m.) of tubing and one test snpecimen for the crushing test from every 100 ft. (30.5 m.) of tubing.

The specimens for the crushing tests shall have a length of 1.5 times the diameter of the tube.

Whenever possible the selection of test specimens shall be made by heats.

Dimensions and Tolerances—8. (*a*) The following tolerances will be allowed on the outside diameter of tubes:

Tubes under 1.5 in. (38.1 mm.) diameter, ± 0.003 in. (0.08 mm.).

Tubes over 1.5 in. (38.1 mm.) diameter, ± 0.005 in. (0.13 mm.).

The manufacturer and purchaser shall agree upon tolerances for coulissant or telescoping tubes.

(*b*) The variation in wall thickness may be ± 10 per cent of the dimension specified.

(*c*) In no part of any tube shall the departure from straightness exceed 1 in 600.

Delivery, Packing, and Shipping—9. All tubes shall be well oiled and delivered in boxes not exceeding 220 lb. (100 kg.) gross weight.

3N3—Specifications for Phosphor Bronze Castings for Bearings

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Use.—2. This material is suitable for liners in babbitted bearings.

Material.—3. The chemical composition shall be as follows:

	Per cent.
Copper	79.00-81.00
Tin	9.00-11.00
Lead	9.00-11.00
Phosphorus	0.10- 0.30
Total impurities, maximum	0.25

Manufacture.—4. (*a*) The material shall be made from lake or electrolytic copper conforming to the I. A. S. B. specification 2N2 and from pig tin at least 99 per cent pure.

(*b*) No scrap shall be used other than that produced in the manufacturers' own plants and which is of the same composition as the material specified.

Workmanship and Finish.—5. Castings shall be homogeneous and free from shrinkage cracks, spongy spots, blowholes, and foreign matter. Castings in which defects are revealed by machining operations shall be replaced by the manufacturer. The full weight of the original material in rejected castings shall be returned to the manufacturer.

Dimensions and Tolerances.—6. Castings must be true to pattern; cores must be correctly placed. Surfaces which are to be machined shall admit of finishing to the required dimensions without leaving any trace of the original surface.

3S20—Specifications for Cold-Rolled or Drawn Carbon Steel Bars

General.—1. The general specifications. 1G1, shall form, according to their applicability, a part of these specifications.

Use.—2. These bars are suitable only for low-stressed parts.

Material.—3. The material for these bars shall be chosen from the I. A. S. B. standard carbon steels listed below. The composition shall be stated by the manufacturer or contractor, and is further limited as follows: Carbon, not over 0.25 per cent.

Manufacture.—4. The steel shall be manufactured, or at least finished, by the open-hearth, electric-furnace, or crucible process.

Workmanship and Finish.—5. (*a*) The bars are to be bright and clean, sound, straight, free from pipes, laps, cracks, twists, seams, and damaged ends, and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture capable of being turned and threaded readily, and of taking a good finish.

(*b*) Any bar may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously passed inspection; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Physical Properties and Tests.—6. The bars shall have the following physical properties:

Tensile Test.—(*a*)

	Bars not over 0.75 in. (19.08 mm.) diameter or width across the flats.	Bars over 0.75 in. (19.08 mm.) and not over 1.50 in. (38.10 mm.) diameter or width across the flats.	Bars over 1.50 in. (38.10 mm.) diameter or width across the flats.
Minimum tensile strength	70,000 lbs./in.^{2}	70,000 lbs./in.^{2}	65,000 lbs./in.^{2}
Minimum yield point	50,000 lbs./in.^{2}	50,000 lbs./in.^{2}	50,000 lbs./in.^{2}
Minimum elongation in 2 inches or proportion gauge length	20 per cent.	17 per cent.	15 per cent.
Minimum reduction of area	40 per cent.	38 per cent.	35 per cent.
Minimum tensile strength	49.2 kg./mm.^{2}	49.2 kg./mm.^{2}	45.6 kg./mm.^{2}
Minimum yield point	35.1 kg./mm.^{2}	35.1 kg./mm.^{2}	35.1 kg./mm.^{2}
Minimum elongation in 2 inches or proportion gauge length	20 per cent.	17 per cent.	15 per cent.
Minimum reduction of area	40 per cent.	38 per cent.	35 per cent.

Bend Test.—(*b*) Bend-test pieces from bars of 0.75 in. (19.05 mm.) or less diameter (or width across the flats) shall be tested in full size as rolled or drawn. Above 0.75 in. (19.05 mm.) diameter (or width across the flats) the test pieces may be turned down from the bar to a diameter of 0.756 in. (19.08 mm.). The test pieces shall withstand bending cold through an angle of 180 deg. over a radius equal to their diameter (or width across flats) without fracture.

Selection of Test Specimens.—7. (*a*) The bars shall be grouped by heats or melts into lots conforming to the size limits given in paragraph 6. The inspector shall select at random 1 per cent, but not less than three bars of each lot to be representatives of the sizes in the lot. One tensile and one bend test specimen shall be cut from each bar.

(*b*) For sizes over 1.50 in. (3.86 cm.) in diameter or width across the flats, one tensile and one bend specimen shall be taken from a bar of each size represented in the lot.

(*c*) The bars and specimens shall be stamped for identification. Whenever bars can not be grouped by heats or melts, one tensile and one bend test specimen shall be taken from each lot of 100 bars or less. The provisions as to grouping by size limits and provisions for bars of over 1.50 in. (3.86 cm.) diameter, as given above, shall apply.

(*d*) The specimens shall not be annealed or otherwise treated before they are tested. They are to be tested in full section, unless the bars are to be subsequently reduced in section by machining. In this event, the tensile specimens may be machined to standard sizes in accordance with specification 1G1.

Dimensions and Tolerances.—8. The dimensions and tolerances shall be those given in the specification 3S11.

Delivery, Packing, and Shipping.—9. (*a*) All bars shall be suitably greased for protection against corrosion.

(*b*) The bars shall in general be grouped in bundles weighing not more than 220 lb. (100 kg.), unless otherwise agreed between manufacturer and purchaser: the heat number and the I. A. S. B. steel serial number shall be plainly marked on a metal tag attached to each bundle. If bars are not so grouped and bundled, each bar shall be plainly marked with the heat and the I. A. S. B. steel serial number.

COMPOSITIONS OF STANDARD STEELS.

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.
1010..	0.05–0.15	0.30–0.60	0.045	0.050
1015..	.10– .20	.30– .60	.045	.050
1020..	.15– .25	.30– .60	.045	.050

When electric or crucible furnace steel is specified in the order, the maximum allowable percentage of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

3N7—Specifications for Seamless Brass Tubes

General.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

Use.—2. This tubing is resistant to the corrosive action of salt water, salt air and gases.

Material.—3. (*a*) The brass shall have the following composition:

	Per cent.
Copper	79.00 to 82.00
Lead, maximum	.20
Iron, maximum	.10
Zinc	Remainder.

(*b*) Samples for analysis may consist of turnings taken from the end of the tube or of drillings. Points from which drillings are taken must be distributed around the surface of the tube so as to yield a representative sample of the tube wall.

Manufacture.—4. (*a*) The brass shall be made from lake or electrolytic copper conforming to the I. A. S. B. specification 2N2 and from B or C grade spelter conforming to I. A. S. B. specification 2N3.

(*b*) No scrap shall be used other than that produced in the manufacturer's own plants and of the same composition as the material specified.

(*c*) Tubing shall be semiannealed unless otherwise specified.

(*d*) Any sheet may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously passed inspection; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

Workmanship and Finish.—5. The tubing shall be clean, smooth and free from all injurious defects, both inside and outside.

Physical Properties and Tests.—6. (*a*) *Flattening Test.*—A piece of tube, 2 diameters in length, shall be flattened with a hammer until it passes freely through a micrometer caliper set at three times the thickness of the tube wall. The tube must stand this test without showing cracks or other defects.

(*b*) ***Expanding Test.***—A pin with a taper of one in eight shall be driven into one end of the tube until the tube's diameter is increased by one-sixth. The tube must stand this test without showing cracks, splits, or other defects.

(*c*) *Hydrostatic Pressure Test.*—Each tube shall be subjected to a hydrostatic pressure which will develop a tensile stress of 7000 lb. per sq. in. (4.92 kg./mm.^{2}) in the tube, but in no case shall a test pressure of more than 1000 lb. per sq. in. (0.703 kg./mm.^{2}) be required. Each tube must withstand this test without cracks, flaws, leaks, or other defects such as bulging.*

Selection of Test Specimens.—7. (*a*) Each tube shall be subjected to a hydrostatic test. One tube from each lot of 100 or less shall be subjected to a flattening and to an expanding test.

(*b*) If any tube fails to pass the flattening or the expanding test, two more tubes representing the same lot shall be subjected to both tests. If either of these tubes fail in either test the lot which they represent shall be rejected.

(*c*) Any tube failing to meet the hydrostatic test shall be rejected.

Dimensions and Tolerances.—8. (*a*) *Tolerances.*—The following tolerances shall be allowed on wall thickness and outside diameter:

TOLERANCES FOR OUTSIDE DIAMETER AND WALL THICKNESSES.

Outside diameter.	Tolerances on outside diameter.	Wall thickness.	Wall-thickness tolerance.
Inches.	*Inch.*	*Inch.*	*Inch.*
0–0.50	±0.002	0–0.0156	±0.001
0.51– .75	± .0025	0.0157– .0312	± .002
.76–1.00	± .003	.0313– .0625	± .003
1.01–1.25	± .0035	.0626– .1250	± .005
1.26–1.50	± .004	.1251– .2500	± .008
1.51–1.75	± .0045	.2501– .3125	± .0125
1.76–2.00	± .005	.3126– .3750	± .0150
2.01	±(.25%)		
Millimeters.	*Millimeter.*	*Millimeters.*	*Millimeter.*
0–12.70	±0.05	0–0.397	±0.03
12.71 –19.05	± .06	0.40 – .79	± .05
19.06 –25.40	± .08	0.791 –1.59	± .08
25.41 –31.80	± .09	1.591 –3.17	± .13
31.81 –38.10	± .10	3.171 –6.35	± .20
38.11 –44.45	± .11	6.351 –7.94	± .32
44.46 –50.80	± .13	7.941 –9.53	± .38
50.81	±(.25%)		

(*b*) *Length.*—When no length is specified, tubes may be shipped in stock lengths of 10 ft. (3.04 m.) to 14 ft. (4.27 m.). When ordered in definite lengths no length shall be less than that specified.

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* The pressure to be applied shall be calculated from the formula

$$P = \frac{7{,}000\ T}{R}$$

Where P = the hydrostatic pressure in pounds per sq.in.
T = the thickness of the tube wall in inches.
R = the internal radius of the tube.

Italian Airplane Record

Lieutenant Brachpapa of the Italian Army and a passenger recently attained a height of 7025 meters (23,048 ft.) in an Italian airplane, mounting to this altitude in 65 minutes.

On July 14, 1914, a German pilot named Oelerich attained a height of 25,756 ft., the record, however, not being passed upon by the Federation Aeronautique Internationale in Paris owing to the outbreak of the European war shortly afterward. H. G. Hawker, an English flier, reached a height of 23,622 ft. on April 26, 1916, at Hendon, England.

Digest of the Foreign Aeronautical Press

Aeronautics (London), November 14, 1917

Supremacy of the Air.—Mr. Bonar Law, speaking on war achievements at the Free Trade Hall, Manchester, on Nov. 7, gave the following facts about the work of the Air Service:

"In airplanes we had made immense advances. The number of airplane engines turned out last month was exactly three times more than in October last year. We had secured air supremacy on the front.

"Last September we dropped 1700 bombs upon places in the West from which enemy airplanes come. We did more damage to the enemy in that month than he had done in all the raids he had made upon England since the beginning of the war.

"We had a considerable number of machines bombing German towns, and, though it was only a beginning, more had already been done than the public realized."

Enemy Raid Admissions.—There has recently reached England a remarkably interesting book entitled "Deductions from the World War," by Lieutenant-General Baron von Freytag-Loringhoven, now stationed at Berlin as Deputy-Chief of the General Staff.

Freytag, in his chapter on "The Technical Developments of the War," has various interesting passages on aircraft and air raids. After remarking that airplanes have acquired a superiority over airships in land warfare, he says:

"The Zeppelins are extraordinarily sensitive. They have to keep at considerable heights, because they provide very large targets. This reduces the accuracy with which they can aim bombs. They also need a large expenditure of labor and materials, and they have to be housed in sheds. The brilliant invention of Count Zeppelin provided a weapon which, especially at the beginning of the war, was of great moral importance, and was also of indisputable value, because with the Zeppelin we got over to England; but in this sphere also the large fighting airplane has taken its place . . . Aviation, obviously, has a great future. Its possibilities of development are numerous."

As regards air raids, he remarks: "Unfortified places of no military importance have had to suffer. The bombardment of these places is in itself objectionable, but the limits of what is permissible are in this matter in many ways elastic. A new weapon opens up its own paths, as is shown, for example, by the submarine war. In any case, in this struggle of the peoples, with its economic background, the war is turned more and more against the enemy countries, and the principle hitherto accepted that war is made only against the armed power of the enemy is in this, as in other spheres, relegated to the background."

Aeronautics (London), November 21, 1917

A Zeppelin Surprise. By Jhadoo Jahaz.—The writer examines the conditions which the Zeppelin airships had to fulfill, during their last raid on the British Isles, in order to reach the extraordinary altitude from which they delivered their attack.

For this purpose the author had at his disposal the following table of estimated weights of the Zeppelin L-49, which had been prepared by Mr. Warner Allen:

	Tons.
Hull framework	12
Outer cover and gas bags	5
Plates	1
Framework of cars	1
Power plant	2½
Fuel tanks	1½
Armament, wireless	½
Miscellaneous	1
Total	24½

The gross lift of the modern Zeppelin being assumed as 60 tons, it follows that 35½ tons remain available for "disposable weights," such as crew, fuel, bombs, and water ballast. Of this, 1½ tons are taken up by the crew, 5½ tons by the fuel supply, and 2½ tons by the bombs, so that the Zeppelin must carry in the neighborhood of 26 tons of ballast. The latter amount the Zeppelin fully needs for attaining the 20,000 ft. level, provided allowance is made for additional dynamic lift.

It will be seen that these figures closely tally with those computed in the Dec. 15 issue of AVIATION AND AERONAUTICAL ENGINEERING, although there is necessarily a certain variance between the two estimates of weights of the structural parts of the Zeppelin.

The Aeroplane (London), October 10, 1917

Reorganization of the German Flying Corps. By "Austerlitz."—Following the defeat of the Somme, the German Flying Corps was totally reorganized, as its inferiority to the Allied Air Services had been fully proven.

There are at present four major tactical formations within the German Flying Corps; these are:

(1) Army squadrons
(2) Army corps squadrons
(3) Pursuit squadrons
(4) Battle wings

1. The Army squadrons are primarily employed for strategical reconnaissances, but may sometimes be detailed on photographic work, and even bombardments.

The machines forming the Army squadrons are two-seater tractor biplanes of from 41 to 45-ft. span, and are fitted with a stationary Benz or Mercédès engine developing from 225 to 240 hp. Their horizontal speed is from 100 to 105 m.p.h.

The armament consists of (1) two machine guns, one of which is mounted on a fixed emplacement in front of the pilot, and fires through the propeller by means of a synchronizing device; the other machine gun is mounted on barbette, aft of the pilot, on the observer's seat; (2) one or two bomb gears, munitioned with four or six bombs.

2. The army-corps squadrons are assigned to tactical reconnaissance, photography, gun spotting, and, during active operations, contact patrol work between the units engaged in an advance.

The army-corps squadrons are equipped with machines which are in every way similar to those forming the Army squadrons, except for a smaller power plant, which endows them with lesser speed.

The armament is the same as on the Army squadron type. Provision is made on these machines for the quick exchange of the bomb gear against a radio installation or a photographic apparatus.

3. The pursuit squadrons are assigned to the defense of the army-corps squadrons engaged in tactical reconnaissance work, but they are also employed, in some instances, on convoy duty with bombers and for the destruction of the Allied kite-balloons.

There appear to be, at present, on the Western front about forty pursuit squadrons, each of which consists of twelve machines. In some instances two or more squadrons are combined into pursuit wings, which are placed under the leadership of particularly capable chiefs.

A number of pursuit squadrons are detached to the local defense of important German towns.

The pursuit squadrons are equipped with one-seater biplanes of from 28 to 30-ft. span, which are fitted with a 175 hp. Mercédès engine driving a tractor screw. The horizontal speed of these machines is from 110 to 125 m.p.h.; they are principally built by Albatros, Fokker, L. T. G. (Lufttorpedo-Gesellschaft), and Roland.

The armament consists of two Spandau machine guns, mounted "fixé" in front of the pilot, which are synchronized to fire either simultaneously or alternately through the propeller. No bomb gear is provided.

4. The battle wings are placed under the direct orders of General Headquarters, and are not, as a rule, permanently assigned to particular sectors.

These wings consist of from forty to fifty machines, and are subdivided into four or five squadrons. The machines are mostly Gotha twin-pusher biplanes. A certain number of bomber squadrons are, however, equipped with A. E. G. twin-tractor biplanes, and a huge Rumpler bomber will shortly be placed in commission, unless it is already in service.

The Aeroplane (London), November 21, 1917

Germany's Air Chief.—In November last the whole air power of the German Army was united under the command of a single chief, General von Hoeppner, who had served through the Somme battle as Chief of Staff of General von Buelow's army. General von Hoeppner left the Somme fully convinced that the Allies owed their success to their superiority in the air, and he set to work instantly to redress the balance. It is to the energy and inventiveness of this officer that the

Germans owe the recovery of their air service that we have witnessed this year.

General von Hoeppner's first business on assuming his post was to start a campaign in the army and in the country in support of air service. The Press was fed with suitable articles, interesting accounts of the feats of German airmen, etc.; and an air war exhibition was held in Berlin. Young officers of other arms were encouraged to become air men. The results of all this advertising were highly satisfactory.

Similar efforts have been made to improve and multiply the flying material of the army. Wherever a factory could be found with suitable plant not already making airplanes or airplane parts, General von Hoeppner pressed it into his service. To increase the output of the factories, types, both of airplanes and engines, were, as far as possible, standardized, and product was concentrated on the four types selected—the Albatros fighting machines, the Albatros observation two-seater, and the Deutsche Flugzeugwerke and General Electrical Company (A. E. G.) models. Similarly, attention was centered on the production of Benz and Mercédès engines, at first 100 hp., and later of 200 and 260 hp., to the neglect of other makes.

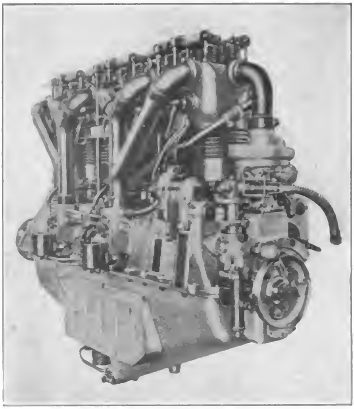
General von Hoeppner is the chief promoter of the Gotha machine, for which he has placed large orders with the Erfurt factory that builds them. Lately he has been supplying the battle squadrons with a large number of airplanes carrying two machine-guns, and the observation machines have been improved in speed and armament.

General von Hoeppner has done his utmost to bring his aerodromes up to the highest state of efficiency. The personnel is abundant. Each flight of six airplanes has in its service a complement of from 100 to 120 men. To each machine there are four mechanics, and every squadron has its own train of motor transport, motor-cars, etc. The aerodromes are protected as well as possible from air attack by anti-aircraft guns, of which the air service has no fewer than 600, including a large number of 4-in. pieces.

***Flight* (London), December 6, 1917**

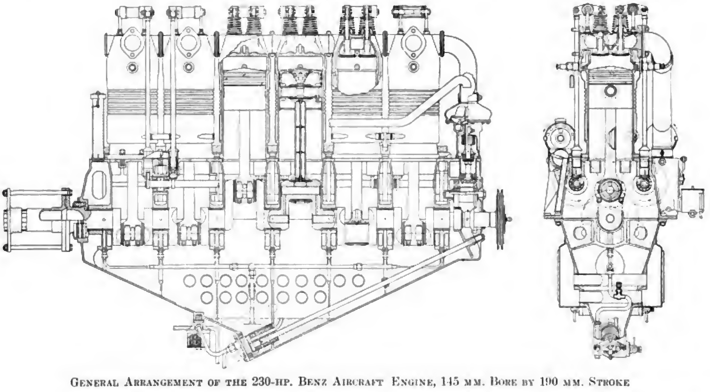
The 230 Hp. Benz Aero Engine.—This engine embodies the usual German aircraft engine practice; that is, it is of the 6-cylinder, stationary, water-cooled type. In its constructional details it is virtually identical to the 160 hp. Benz model that was described in the Dec. 1, 1917, issue of AVIATION.

Each cylinder is bolted to the crankcase by long bolts and studs, which pass through the crank chamber top half and secure the crankshaft bearings between the top and bottom halves of the crank chamber.



REAR END OF 230-HP. BENZ AIRCRAFT ENGINE

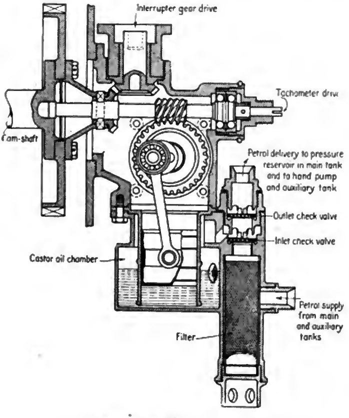
The cylinders are of cast iron, with built-up steel water jackets, the water-jacketed heads being cast integral with the cylinders. Two inlet and two exhaust valves are fitted in the cylinder heads, and are operated by overhead rocker arms working on ball-bearings and by push rods on either side of the cylinders, whereas on the 160 hp. model the push rods were all on one side of the cylinders. (In the description above referred to, the valve mechanism of the 160 hp. Benz was, on p. 611, mentioned as being of the overhead camshaft type. This was a typographical error.—EDITOR.)



GENERAL ARRANGEMENT OF THE 230-HP. BENZ AIRCRAFT ENGINE, 145 MM. BORE BY 190 MM. STROKE

The two camshafts run, on the 230 hp. model, on plain bearings, inside the top half of the crank case, and the floating exhaust camshaft is provided with half-compression cams.

The pistons are of cast iron, fitted with three exceptionally wide rings, and the piston heads are supported by conical steel forgings riveted and welded to the piston crown—an arrangement which is of the notable features of Benz practice.


Interrupter gear drive
Tachometer drive
Cam-shaft
Petrol delivery to pressure reservoir in main tank and to hand pump and auxiliary tank
Outlet check valve
Inlet check valve
Castor oil chamber
Petrol supply from main and auxiliary tanks
Filter

Oil Pump of the 230-hp. Benz Engine

The bore of the 230 hp. model is 145 mm., the stroke 190 mm. Two separate two-jet carbureters are fitted, each of which supplies three cylinders through an independent branched induction pipe, built up of light aluminum tubing.

The lubrication is effected by a gear pump working in an auxiliary oil reservoir formed in the bottom of the base chamber. An oil-sealed gasoline pump feeds the carbureters in conjunction with a supplementary pressure reservoir enclosed in the main gasoline tank. This pump is driven off the rear end of the inlet camshaft. The same driving spindle also operates the machine-gun interrupter gear and the tachometer drive.

From the delivery of the pump gasoline is forced into the top of the pressure reservoir inside the main gasoline tank, and, rising in the reservoir, creates a cushion of compressed air above the gasoline, thus serving to damp out the pulsations arising from the action of the pump.

In the earlier types the castor oil chamber was provided with an oil-filling cap, which was screwed into the side of the chamber casting, and was fitted with a special form of drain cock to determine the quantity of oil poured into the pump. This filling arrangement has now been given up, and the annular oil chamber is fitted with a drain plug only.

Flight (London), November 1, 1917

French and British Aero Engines.—The following data on French and British aero engines appeared in a German aviation magazine; the accuracy of the information cannot, therefore, be vouched for:

The Renault firm of Billancourt, France, produces both water and air-cooled engines of the stationary V type. The air-cooled models have a bore of 105 mm. and a stroke of 130 mm. The normal power of the 8-cylinder motor is 100 hp., and of the 12-cylinder motor 130 hp. The overall length of the 12-cylinder motor, from the back of the fan housing to the propeller, is 1,450 mm. While the 8-cylinder motor has only one carbureter, the 12-cylinder has two, one for each row. In the 8-cylinder type the magneto is placed above the camshaft, while in the 12-cylinder motor it is placed with its axis at right angles to the crankshaft.

The 240 hp. 12-cylinder water-cooled model has been described in detail in the Aug. 1, 1916, issue of Aviation and Aeronautical Engineering.

The water-cooled Peugeot engine has a 180 mm. stroke to 100 mm. bore. Two exhaust valves and two inlet valves have, therefore, to be employed in each cylinder. The cylinders are arranged in a Vee of 90 deg., and each row of four cylinders is cast en bloc. Each row has its camshaft operating inlet and exhaust valves. The crank case is cast in one piece.

The air-cooled English Daimler was particularly favored by the R. A. F. These motors have become the standard type for the B.E.2, and gave pretty good results with those machines, considering the then prevailing conditions of loading and uses to which they were put. This engine is built in two types, the 100 hp. 8-cylinder and the 150 hp. 12-cylinder.

The cylinders are placed at an angle of 90 deg. In the 150 hp. 12-cylinder type the angle between the cylinders is smaller. The cylinder design is the same as in the 8-cylinder type. While in the Renault the cylinders are held down by means of a four-armed yoke and four bolts, the cylinders of the English Daimler are only held by two bolts each. Since thus the yoke over the top of the cylinder is avoided, it has been possible to provide extra fins on the top of the cylinder, running parallel with the crankshaft. The exhaust valves, as in the Renault, are placed above the inlet valves, and are operated by push rods and rockers. The induction pipes are unusually short, thus avoiding the sharp bends found in the Renault engines. The magnetos are mounted on brackets on the propeller end of the engine.

The 160 hp. 6-cylinder, water-cooled Beardmore engine has steel cylinders with copper water jackets.

French and British Stationary Engines

Name.	Cooling.	No. of Cyls.	Bore.	Stroke.	R. P. M. Motor.	R. P. M. Screw.	Nom. H.P.	Mean Piston Speed.	Str'ke Bore.
Renault	Air	8	105	130	2,000	1,000	90	8.6	1.23
Renault	Air	12	105	130	2,000	1,000	130	8.6	1.23
Renault	Water	8	125	150	1,400	1,400	160	7.0	1.2
Renault	Water	12	125	150	1,400	1,400	240*	7.0	1.2
Peugeot	Water	8	100	180	?	†	?	..	1.8
Daimler	Air	8	100	140	2,000	1,000	100	9.3	1.4
Daimler	Air	12	100	140	2,000	1,000	150	9.3	1.4
Beardmore	Water	6	142	178	1,300	1,300	160**	7.7	1.25
Rolls Royce	Water	12	114	164	1,600	1,024	250‡	8.75	1.44

* 267 b.h.p.
** 164 b.h.p. at 1,300 r.p.m., 168 h.p. at 1,400 r.p.m.
‡ 280 b.h.p.
† Half engine speed.

The Aeroplane (London), November 28, 1917

German Airplane Design.—The September issue of the German aviation magazine, *Deutsche Luftfahrer Zeitschrift*, publishes an article on single-seater fighting airplanes, in which the following phrases appear:

"The demand for surpassing the ceiling of the enemy aircraft made it necessary to increase the area of the airplanes, this being, however, possible no further in the monoplane model. Thus the small-dimensioned, light biplanes were produced, keeping the monoplane body, and here again Fokker turned out one of the most successful types, differing from the other fighting biplanes by obtaining lateral control through warping, as against the ailerons of the others.

"The first Fokker biplane fighters had two sets of struts between the planes on each side of the body; but even though all parts were built light and small, our enemies, demanding no such high safety figures as we, turned out fighting planes which were, owing to their smaller weight, equal to our aircraft; at times even surpassing them.

"This led to re-designing when but one set of plane struts was employed. Thus the head resistance was also reduced, and the Fokker and Albatros, one-set strut biplanes, are still the most employed fighting airplanes. The competition with the airplanes of the enemies, steadily increasing in performance, has forced the German designers to shape all details in the fighting biplane to least weight and highest reduction in head resistance, the foremost results being building the engines into the bodies; another object being to reduce the rudder and elevator areas to a minimum, some designs doing away even with fixed tail planes and fins, as in the Halberstadt type."

National Advisory Committee's Annual Report

Following is an extract from the annual report of the executive committee of the National Advisory Committee for Aeronautics covering its activities during the fiscal year 1916-1917:

General Recommendations

In the latter part of March, 1917, when war with Germany seemed imminent, the committee, in conference with United States military and naval officers and manufacturers of aircraft, reviewed the condition of the aeronautical industry, the facilities then existing in this country for meeting the requirements of the Government, the possibilities of adequate expansion, and the then patent situation and its influence on the aeronautical industry.

A subcommittee was appointed to cooperate with representatives of aircraft manufacturers and to investigate all problems entering into the quantity production of aircraft for the Government. After a careful study of the conditions then existing the Advisory Committee submitted recommendations to the War and Navy Departments for increasing the quantity production of aircraft and urging the adoption of a continuing program of manufacture for the next three years.

In early April the chairman of the executive committee conferred with the Secretary of the Navy and the Secretary of War as to the best method to obtain the most efficient results in the development of aviation and the supply of aircraft for military and naval purposes, stating that the Advisory Committee deemed it desirable to create an aeronautical service with a civilian head, but not a distinct Government department. This met the informal approval of the two secretaries and after a thorough study of the problem the committee recommended to the Council of National Defense that a board be appointed by the Council of National Defense, with the approval of the Secretary of War and the Secretary of the Navy, to be known as the Aircraft Production Board, whose duties would be to consider and deal with the problems arising in connection with the quantity production of aircraft in the United States for military purposes. The Advisory Committee further recommended that the Secretary of War and the Secretary of the Navy appoint a Joint Technical Board of the Army and Navy for determining specifications and methods of inspection for all aircraft requirements for the two services.

Ground Schools for Aviators

Supplementing the recommendation made to the Secretary of War and to the Secretary of the Navy that a continuing program be approved for the production of aircraft, on April 13 the committee recommended to the Council of National Defense that the several problems connected with the establishing of cadet training schools for aviators and with the production of aircraft should be considered together as interrelated problems and should also be considered jointly for the uses both of the Army and Navy.

The committee further, at the suggestion of and in cooperation with the War Department, took the initiative in organizing the several ground or cadet schools for the preliminary training of aviators in this country and in determining the curriculum and methods of carrying on this instruction.

To this end the committee took under consideration the different methods of training used by Great Britain and France.

On recommendation of the committee, the War Department selected the following six colleges for the establishment of ground-school training in aeronautics: Massachusetts Institute of Technology, Cornell University, Ohio State University, Illinois University, University of Texas and University of California. Later Princeton University and Georgia School of Technology were added.

Aeronautical Patents

In January, 1917, the War and Navy Departments called the attention of the Advisory Committee to the prohibitive prices of aircraft charged by the various aircraft manufacturers, attributing these prices to the extra item of royalty added by each firm in anticipation of infringement suits by owners of alleged basic aeronautical patents, who were then threatening all other airplane and seaplane manufacturers with such suits, and causing thereby a general demoralization of the entire industry.

After numerous meetings with Government officials, owners of patents and aircraft manufacturers, the committee recommended the organization of an association among aircraft manufacturers for the purpose of cross-licensing aeronautical patents between the members, such association to be known as the Manufacturers' Aircraft Association.

The purposes in view in the formation of this association, and which it is believed have been achieved, are the following:

(1) The prevention of the virtual deadlock with danger of monopoly existing under the patent situation as obtaining previous to its consummation, and the removal of restraint upon the trade operative under the existence of such situation.

(2) The settling or avoiding of all litigation, actual and prospective, under the previously existing patent situation.

(3) The opening of the industry to free competition of all airplane manufacturers and the opening of all patents held by the membership of the association to equal use and on equal terms.

(4) Provision, as set forth in the articles of agreement, whereby a design originating with a given manufacturer may be put into production and used by another manufacturer with all design data, drawings, specifications, etc., on the payment of a small fee, thus facilitating quantity production of an approved design and stimulating the production of new designs or processes.

(5) The development and financial stability and confidence in the airplane industry, thus making possible the financing of the absolutely needed expansion in order to take care of the expected demands.

(6) Reduced cost of aircraft to the Government by reduction of airplane royalties payable under all patents made available under the association to an amount less than one-half the figures previously demanded under a part only of these patents.

(7) Broadly speaking, the encouragement of airplane production to the highest practicable degree and with reference to the demands of the Government under war conditions.

Information from Europe

In March, 1917, the committee arranged in conjunction with the National Research Council, for representation on the foreign committee sent abroad by the National Research Council to obtain detailed information on scientific matters of importance in connection with the war, and Dr. Joseph S. Ames, member of this committee, was appointed such representative.

In order to further develop contact with sources of information from abroad, Lieut. Col. L. W. H. Rees, R. F. C., member of the British Commission, together with Maj. Joseph Tulasne, Captain de Guiche and Capt. A. de La Grange of the French Flying Corps and members of the French Commission, were made associate members of the committee, and as such attended its meetings, contributing valuable information and suggestions regarding matters with which they were especially familiar.

Census of Production Capacity

Previous to the entrance of the United States into the present war, the committee had undertaken a census of the production facilities of manufacturers of aircraft and aeronautical engines, which information was made available for use of the Aircraft Production Board at the beginning of its work in April.

Site for Experimental Laboratory

In October, 1916, the committee took under consideration the question of the selection of a suitable site for the committee's proposed experimental laboratory.

At the suggestion of the War Department, requesting recommendation by the Advisory Committee in the matter, this committee inspected several proposed sites and after making inquiries as to the general health conditions and the problems of accessibility to Washington and the larger industrial centers of the East, protection from enemy naval attack, climatic conditions, and cost of the site, it made recommendation to the War Department for the purchase of a site about four miles north of Hampton, Va., which recommendation was accepted by the War Department and the site was purchased.

On this field the War Department has allotted to the committee a space suited to the erection of the committee's proposed research laboratories. The laboratory building is now in the course of construction.

The committee has also under preparation plans for the first aerodynamic laboratory to be installed at Langley Field intended for the development of high wind speeds. The work on this laboratory will be begun as soon as plans are ready.

Airplane Design and Materials

The committee has cooperated with the Aircraft Production Board in connection with a wide variety of problems relating to the design, specifications and tests of aircraft. The committee has now in hand (November, 1917) a most important investigation on the use of steel for airplane construction.

In connection with the subject of the materials for airplane construction, the committee has given its attention chiefly to the investigation of strut forms for airplanes, the strength of spruce bars and the development of cotton airplane fabrics as a substitute for Irish linen.

In the field of power-plant design and construction for aircraft, the committee has cooperated with the Bureau of Standards in the design, construction, equipment and operation of a large vacuum chamber engine testing laboratory, which is intended to reproduce the conditions of aeronautical engines operating at high altitudes. This equipment has been installed with special reference to the development and improvement of the "Liberty" engine, and important investigations bearing on this problem are now being carried forward. The committee has also carried on a number of researches on the subject of radiator design and proportion, carbureter design and adjustment and ignition apparatus, and is continuing its study of the problem of an airplane engine muffler.

Airplane Instruments

The committee has developed an improved form of geographic position indicator, which will be of special value in connection with certain free-flight tests under consideration.

Aircraft Communications

Regarding the subject of aircraft communications, the committee has cooperated in the development of a generator for wireless sending from airplanes and intended to satisfy the requirements of the Army and Navy. Means for receiving wireless signals in an airplane have also been investigated and it has been established that a very efficient receiving set employing the sound method is practicable. Investigations are still being carried on regarding means for detecting hostile airplanes before they are visible or before they can be heard by the unaided ear.

Mapping from Airplanes

On March 8, 1917, the committee took under consideration the development of methods for mapping from airplanes. Allotments were made for developing a new type of airplane mapping camera and gratifying progress has been made in the development of such an instrument.

Meteorology

In the field of meteorology, the committee recommended to the President an appropriation for the extension of the aerological work of the U. S. Weather Bureau, and in accordance with which an appropriation of $100,000 was made by Congress for this work.

In August, 1917, the Advisory Committee recommended that there be organized under the Chief Signal Officer of the Army, as a war measure, a military aerological service with necessary stations and equipment, both in the United States and abroad.

Board of War Inventions in Aeronautics

The committee, through an appropriate subcommittee appointed for the purpose, has acted as a board of inventions for the Government in matters relating to aeronautics, and since the outbreak of hostilities between the United States and Germany it has weekly examined hundreds of suggestions and inventions pertaining to this subject.

Definition of Technical Terms

During the year the committee has given further attention to the subject of the definition and standardization of technical terms used in aeronautics, and has prepared a further edition of its bulletin on the subject. (Technical Report No. 15.)

Metric System Adopted

On recommendation of the Advisory Committee, in December, 1916, the War, Treasury, Interior and Commerce Departments adopted the metric system of weights and measures for all drawings and calculations on aeronautical matters, for use with the accompanying English equivalents.

Aerial Mail Routes

In December, 1916, the subject of cooperation with the Post Office Department in the establishment of aerial mail routes was considered. Recently the Second Assistant Postmaster General has expressed a desire to develop such routes in a trial way and so far as military requirements may permit furnishing the needed equipment and personnel.

Civil Aerial Transport

In the latter part of 1917 a special subcommittee was appointed to take under consideration the various phases of civil and commercial uses of aeronautics with special reference to the conditions which may be expected to develop at the close of the war.

Landing Field for Transient Aviators

In connection with the accommodation of transient aviators, and in cooperation with the War Department, a tentative selection of a tract of land was made on the Eastern Branch and southeast of the Washington Navy Yard.

Technical Reports

The following is a list of technical reports which have been collected by the executive committee for publication in the third annual report (Reports Nos. 1 to 12, inclusive, were published in previous annual reports):

No. 13. Meteorology and Aeronautics.
No. 14. Experimental Research on Air Propellers.
No. 15. Nomenclature for Aeronautics.
No. 16. The Stretching of the Fabric and the Deformation of the Hull in Full Balloons.
No. 17. An Investigation of the Elements which Contribute to Statical and Dynamical Stability and of the Effects of Variation in those Elements.
No. 18. Aerofoils and Aerofoil Structural Combinations.
No. 19. Periodic Stresses in Gyroscopic Bodies with Applications to Air Screws.
No. 20. Aerodynamic Coefficients and Equivalents in Different Systems of Units.
No. 21. Theory of an Airplane Encountering Gusts, II.
No. 22. Fabrics for Aeronautical Construction.
No. 23. Aeronautical Power Plant Investigations.

Annual Report of the Chief Signal Officer

The work of the Signal Corps has included the development of the Army's air program, the installation, operation, and maintenance of military telegraph and telephone systems, and radio ship and shore stations, the installation and maintenance of annunciator-buzzer and other target-range communication systems, the supply of the signal-unit accountability equipment to the several components of the Army, and the supply of material for the maintenance of fire-control systems and radio and signal stations for coast defenses.

At the commencement of the fiscal year 1917 the Mexican border mobilization was in progress. The Signal Corps met its requirements for that additional work with some difficulty. After some months the situation was relieved by an appropriation for the air service, about ten times as great as the total amount appropriated for such service during the preceding four years. Additional increase in personnel through the Reserve Corps was also authorized and the corps given authority to proceed with the organization of units and the purchase of equipment to meet existing needs.

The Signal Corps had at its disposal at the outbreak of the present war the nucleus of its war personnel and complete information as to the possibilities of the material market, and with the assistance of the National Advisory Committee for Aeronautics, the National Research Council, and the Council of National Defense, immediately acted to meet the emergency. Conditions made necessary a special air program. Congress approved of the air program and the bill was signed by the President July 24, 1917.

Following is a statement of the Government boards directly associated with the office of the Chief Signal Officer, the several divisions necessarily established in that office to meet existing conditions, and a general statement of the duties of each:

Council of National Defense—Aircraft Production Board

This board was established by resolution of the Council of National Defense of May 16, 1917, to consider matters relating to the quantity production of aircraft in the United States and to cooperate with the Army and Navy in furthering their air programs. In its advisory capacity the board has rendered invaluable aid to the Signal Corps.

Joint Army and Navy boards on aeronautical cognizance, design and specifications, Zeppelins, and on technical aircraft were created and have insured the desired cooperation between the War and Navy Departments.

Air Division

This division of the office of the Chief Signal Officer of the Army has general supervision over all matters pertaining to aviation. It handles all matters of design and development of airplanes; the selection, training, and commissioning of the officers of the aviation section; the recruiting and organizing of its enlisted personnel for duty at home and abroad; the training of aviators and the conduct and operation of aviation schools and stations.

The following table shows the sum appropriated for Army aviation purposes:

1912	$125,000
1913	100,000
1914	125,000
1915	250,000
1916	300,000
1916-17, urgent deficiency	500,000
1917	13,281,666
1917-18, urgent deficiency	43,450,000

On July 1, 1916, twenty-three officers of the Regular Army had completed their training in aviation and were serving on duty with the aviation section of the Signal Corps. Twenty-six other officers were under instruction. A small number of firms was making airplanes or airplane engines. With one or more exceptions practically none of these were producing more than an occasional machine, and most of the product had been contracted for by foreign governments. Five officers were in Washington charged with the duty of overseeing the expansion of the aviation section of the Signal Corps.

The problem of the fiscal year 1918, therefore, was the problem of preparing a general plan of development, of securing the cooperation of the aeronautical industry and insuring its expansion, and of solving the innumerable scientific and engineering problems which must be met to send men and machines into the air to reconnoiter and to fight over unmapped country.

Many weeks were required to remove the obstacles in the way of obtaining suitable airplanes and airplane engines in large quantities.

Specifications of various types of machines were prepared by a board of technically trained officers assisted by consulting engineers from civil life; the facilities of the Bureau of Standards were used for the testing of various materials; and devices of all sorts which might increase the military efficiency of the aviator received trial.

The money provided by Congress for the purchase of a site for an aeronautical experimental station was used in the purchase of Langley Field at Hampton, Va. This site, ideal for both land and water flying, was selected after a thorough canvass of available tracts.

The national-defense act of June 3, 1916, authorizing the organization of an Officers' Reserve Corps and an Enlisted Reserve Corps was made the basis for training a reserve civilian personnel of flyers and mechanics, and a system of instruction was adopted which, with amplification and modification, is forming the basis of the instruction of war pilots.

When, in April, the United States entered the European war the Chief Signal Officer availed himself of the offers of a number of civilian experts to assist him by advice in meeting the problems of expansion which confronted the aviation service. Representatives of other Governments at war were also consulted and, as a response, experts in every line of aeronautical work were sent to Washington, so that the combined experiences of three nations became available to the United States.

Although training machines could be obtained, the war airplane with its refinements of construction and its engines of unprecedented efficiency was practically unobtainable in the United States in April. The Liberty engine, which for power, lightness, and efficiency compares favorably with the best European types, was under development in June.

By the end of June, 1917, the number of Regular Army officers trained and detailed to aviation duty had been increased from twenty-three to ninety-two, and in addition fifty-four civilians had qualified for commissions in flying capacities in the Signal Reserve Corps. The system of training civilians for commissions had been amplified by the organization of eight schools of military aeronautics, where prospective officers could receive schooling in military discipline, the principles of airplane and engine construction and operation, radiotelegraphy, photography, bombs and bomb dropping, and aerial observation, and at the close of the fiscal year many student officers were under instruction.

The program of action made possible by the Congressional appropriation that became available July 24, 1917, had been practically mapped out before the end of the fiscal year.

Equipment Division

The fiscal year 1917 has shown an abnormal expansion of the work of the equipment division, due to the declaration of war. Many problems of supply and finance have arisen. The formation of many new organizations and the increase in the allowance for such organizations has made it necessary for the corps to secure enormous quantities of mobile army equipment.

Standardization in the types and production of airplanes and airplane engines was initiated with the cooperation of the manufacturing industries of the country. This has involved the reconstruction of factories, in most cases the installation of entirely new equipment and the development of a new organization.

The following shows the disbursements from Signal Corps appropriations during the fiscal year 1917:

Appropriation.	Amount.	Disbursements.	Balance unexpended.
Signal Service of the Army, 1916-17	$250,000.00	$250,000.00	....
Signal Service of the Army, 1917	9,781,766.00	9,781,766.00	....
Signal Service of the Army, 1917-18, act June 15, 1917	47,267,766.00	23,504,470.75	$23,763,295.25
Signal Service of the Army (no year)	4,500,000.00	....	4,500,000.00
Aviation, seacoast defences	3,600,000.00	2,720,589.02	879,410.98
Aviation, seacoast defences, insular possessions (Hawaii)	600,000.00	161,322.03	438,677.97
Aviation, seacoast defences, insular possessions (Philippines)	600,000.00	21,889.64	578,110.36
Aviation, seacoast defences, Panama Canal	500,000.00	....	500,000.00
Maintenance, etc., fire-control installations at seacoast defences	136,792.56	135,053.13	1,339.43
Maintenance, etc., fire-control installations at seacoast defences, Panama Canal	10,000.00	9,349.32	650.68
Maintenance, etc., fire-control installations at seacoast defences, insular possessions	10,653.92	10,647.34	6.58
Washington-Alaska Military Cable & Telegraph System, 1917-18	50,000.00	50,000.00	....
Radio installations on Mexican border, 1916-17	60,000.00	60,000.00	....
Commercial telephone service at Coast Artillery posts, 1917	8,500.00	8,500.00	....

The following shows the disbursements from allotments to the Signal Corps during the fiscal year 1917:

Appropriation.	Amount.	Disbursements.	Balance unexpended.
Fire-control installations	$404,434.59	$378,536.31	$25,898.28
Board of Ordnance and Fortification	25,891.69	263.70	25,627.99
Equipment of Coast Artillery armories, Organized Militia	699.75	699.75	....
Field Artillery for Organized Militia, 1915-1917	11,588.47	11,588.47	....
Arms, uniforms, equipment, etc., for field service, National Guard, 1917	342,227.00	342,227.00	....

News of the Fortnight

Unification of the British Air Services

The unification of the British air services under a single head responsible to Parliament, which has been a long-standing topic in the English press, is now an established fact.

The Air Force Act, 1917, the bill for which was introduced in the House of Commons on Nov. 8 by the Government and passed by both houses in the latter part of November, provides for the establishment of an Air Force, equal in status with and independent of the Navy and the Army, in which the present Royal Naval Air Service and the Royal Flying Corps will be absorbed.

The Air Force Act further provides for the establishment of an Air Council, equal in status with and independent of the Board of Admiralty and the Army Council, which will take the place of the present Air Board. The president of the Air Council is to be a Secretary of State and will hold a position analogous to the First Lord of the Admiralty and the Secretary of State for War. He will be directly responsible to Parliament for all questions involving the personnel and material of the Air Force, and the manufacture, design and equipment of aircraft. While the Air Board is only a consultative body, the Air Council will possess executive power. At present it is proposed that the Air Council shall consist of a Secretary of State, a Chief of Staff, a Sub-Chief of Staff, and two officers who shall be responsible for the personnel and the materiel, respectively.

The Air Force Act also provides for the establishment of an Air Force Reserve and an Auxiliary Air Force, which will have a status similar to that of the Royal Naval Reserve and the Territorial Force.

Miss Stinson in Record Flight

Miss Katherine Stinson established a new American non-stop record for airplane flight on Dec. 11 by flying from San Diego to San Francisco, and covering the distance of 610 miles in nine hours and ten minutes.

Miss Stinson suffered somewhat from the cold, due to the high altitude at which she flew, but otherwise she experienced little discomfort on the long trip. In crossing the Tehachapi mountains, in southern California, she reached her highest altitude of the journey—9,000 ft.

Miss Stinson's flight beats the previous non-stop record of 512 miles, made by Miss Ruth Law, Nov. 19, 1916, between Chicago and Hornell, N. Y.

Miss Stinson started at 7.31 a. m., from the North Island Aviation Grounds at San Diego and arrived at the Presidio Military Reservations at 4.41 p. m. The flight was made in a triplane.

Government Is Using Motor Plant

That part of the machinery and plant of the General Vehicle Co. of Long Island City, N. Y., which is being utilized to turn out the Gnome-monosoupape airplane engine, has recently been taken over by the Government. The company makes the following announcement:

"With respect to certain rumors regarding the General Vehicle Co., Inc., it may be authoritatively stated that while a considerable portion of the Long Island City plant will be devoted to other work than the manufacture of electric trucks, the General Vehicle Co., as well as its manufacture of electric trucks, will continue utilizing such portions of the Long Island City plant as may be necessary for the purpose of continuing its business of nearly seventeen years."

Offer Bonus to Speed Spruce

As a means of speeding up the production of spruce to be used for military airplanes, Col. Brice P. Disque, Signal Corps, U. S. A., in charge of spruce production at Portland, Ore., announced recently that the Government would pay a substantial bonus on all deliveries prior to Feb. 28, 1918, and at the same time announced a new and higher price per thousand feet.

The price was fixed at $90 per thousand feet f. o. b. at the point of inspection, plus a bonus of $40 per thousand feet for all pieces accepted up to Jan. 31, and a bonus of $30 per thousand feet for all accepted up to Feb. 28.

Col. C. G. Edgar Has Been Promoted

Lieut.-Col. C. G. Edgar, U. S. A., who is in charge of the Construction Division of the Aviation Section has been promoted to be a colonel with rank dating from Dec. 1.

Secretary Daniels on the Naval Flying Corps

In his report to the House Sub-Committee of the Naval Affairs Committee as well as in the discussion which followed, Secretary of the Navy Daniels gave the following information regarding the expansion of the Naval Air Service.

The increase in the naval aircraft material has been approximately 1,400 per cent; in personnel, 3,000 per cent; in stations and training schools, 3,200 per cent, and better results are steadily obtained. An estimate of 10,000 machines and 5,000 aviators is well within the correct number to be expected for next spring.

The naval aircraft factory at Philadelphia which was completed within ninety days, is about 400 ft. long and has a floor space of approximately 140,000 sq. ft. It is expected to produce something like 1,000 machines a year of the smaller type, or perhaps one half that number of the larger type, when in full operation. In addition to relieving other manufacturers for Army work, the naval aircraft factory will conduct experimental work. The production end will also supply the Navy with correct figures as to the cost of machines and so protect the service as to expenditures.

Report of the Forester

In the annual report of the Forest Service of the United States Department of Agriculture it is stated that over 500 tests were made from Sitka spruce, white oak, and yellow birch to determine the influence of drying and steaming on strength, with particular reference to use in airplanes.

Kiln-drying tests previous to the entrance of the United States into the war continued along the same lines as in the past. Encouraging tests on structural sizes of Douglas fir show the possibility of kiln drying without appreciable loss of strength. A method was perfected under which hemlock shiplap can be dried to shipping condition with practically no degrade in forty to forty-eight hours, and 2-inch plank in from four to six days. Douglas fir and red and white fir were also dried to practically a perfect condition in forty-eight hours. The time for drying maple last blocks was reduced from twenty-one to two months, and losses reduced from an average of about 15 per cent to 6 per cent. Green basswood was satisfactorily dried in 2-inch thicknesses in thirteen days and 1-inch thicknesses in nine days. Dogwood sticks and iron-wood blocks were dried in comparatively short periods without checking or honeycombing.

No Aero Show to Be Held

The Organization Committee of the Second Pan-American Aeronautical Exposition announces that in order to keep clear of any possibility of adding to the congestion in transportation facilities of the country, it has decided to postpone the exposition, which was to be held at the Grand Central Palace beginning Feb. 16.

As the entire purpose of holding the show was to assist in carrying out the aerial program by the process of education outlined in the first announcement of thé exposition, the committee feels that it can carry out such a program by holding a series of aeronautical conferences instead of holding the show.

Report of the U. S. Naval Observatory

In his annual report to the Bureau of Navigation. Rear Admiral Howard, U. S. N., retired, superintendent of the Naval Observatory, refers to aviation instruments as follows:

In conjunction with the station at Pensacola and other commands engaged in flying, the observatory has practically accepted as standard an altimeter (altitude aneroid barometer) and a clock. A compass for aircraft has been adopted and issued but is not proving entirely satisfactory and further experiments are under way.

One form of statoscope for dirigibles has been found satisfactory for certain purposes and will be issued to each dirigible when delivered. This is the Custer type. This instrument is non-luminous and does not indicate speed or amount of change of height. The observatory is assisting various inventors and makers of instruments to devise a statoscope that will answer all requirements.

The observatory has on hand a small number of airplane cameras of acceptable design. These are not fixed in the car and their value will have to be determined in service. Other forms of cameras are under trial.

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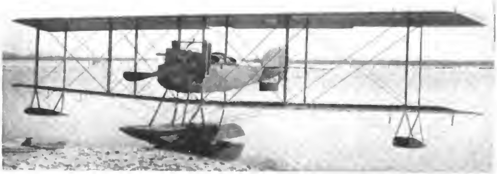

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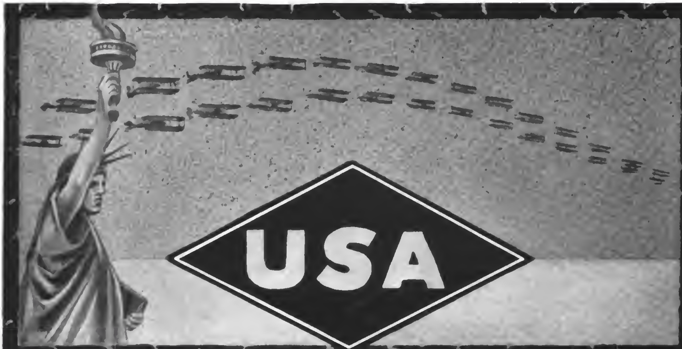

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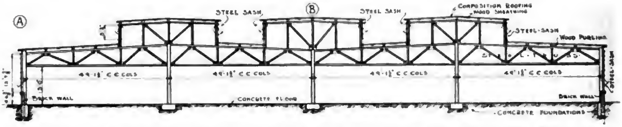

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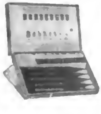

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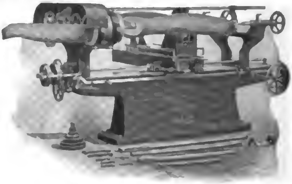

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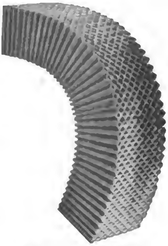

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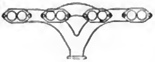

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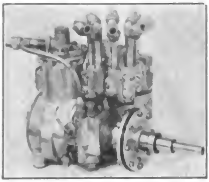

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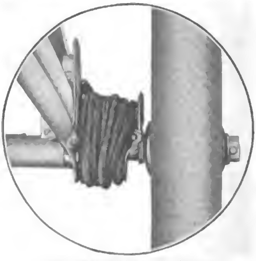

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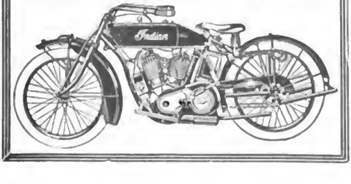

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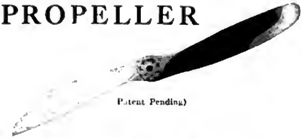

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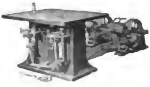

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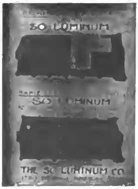

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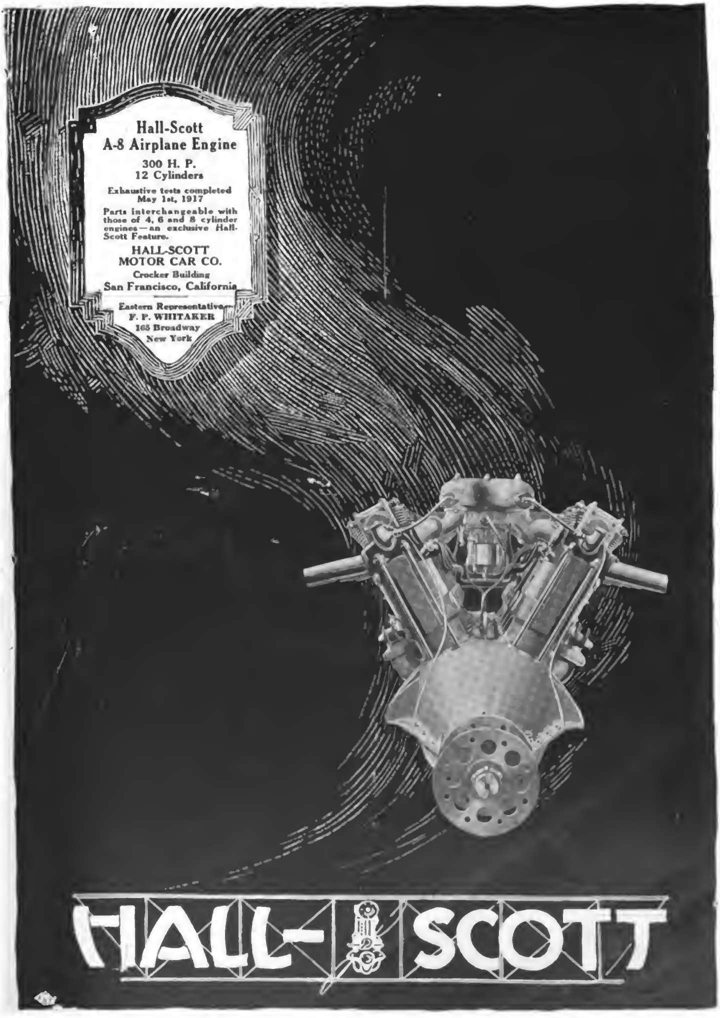
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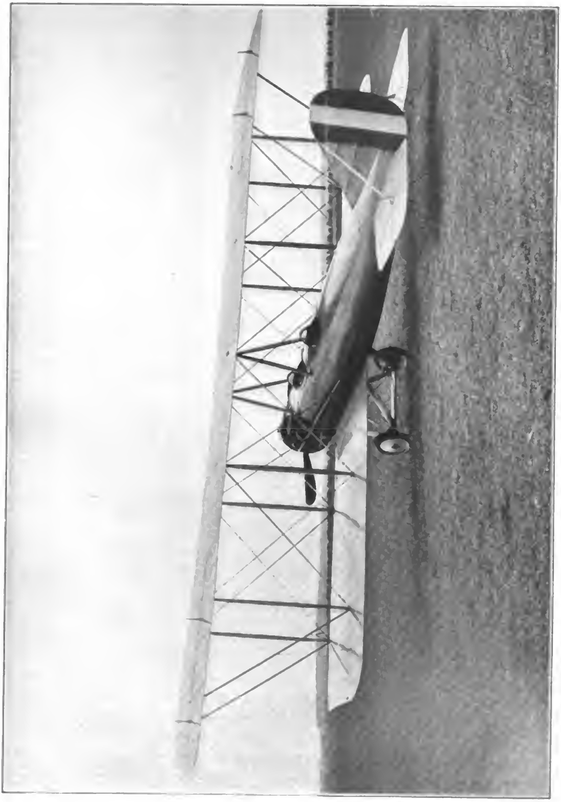

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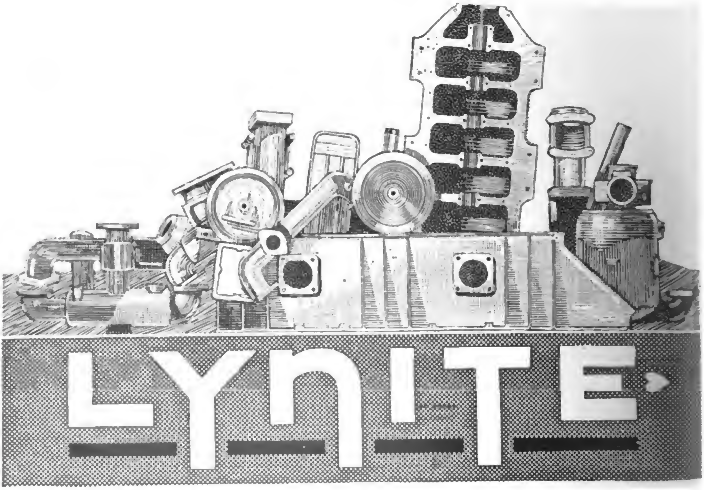

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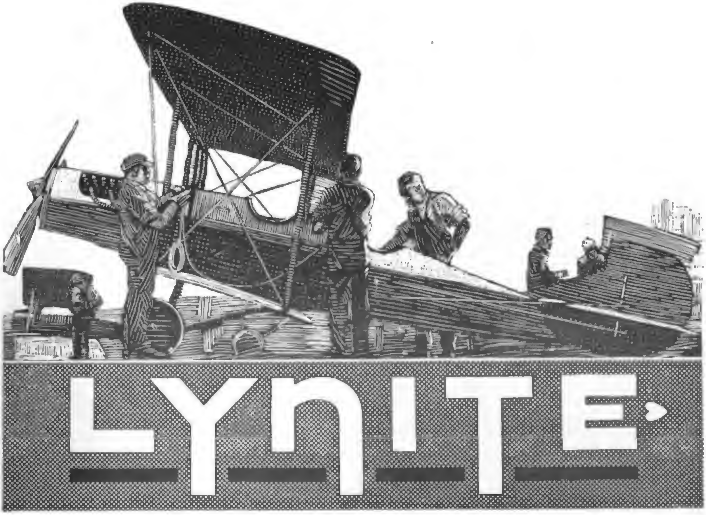

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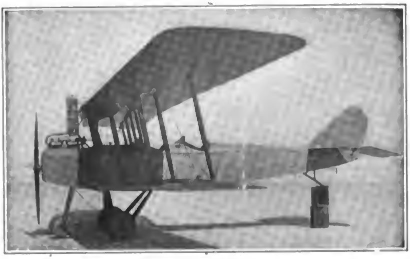

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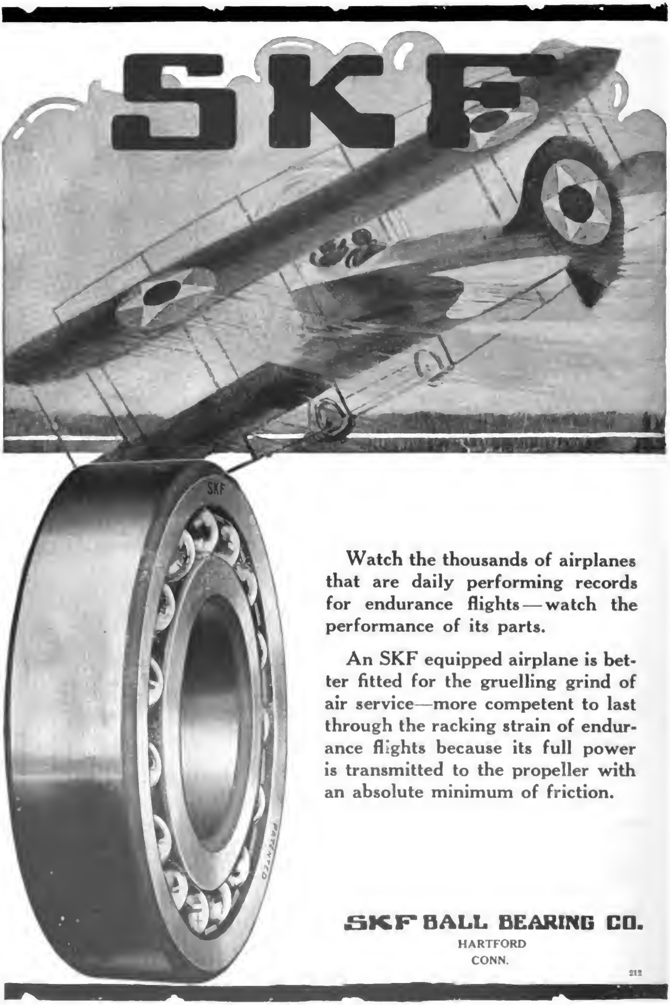

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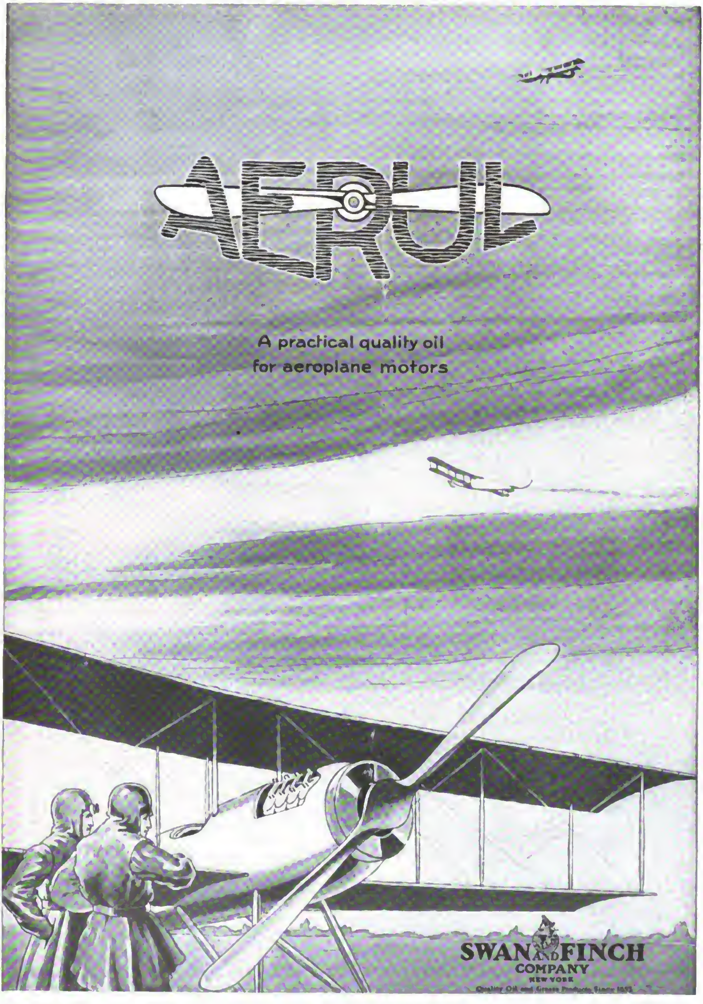
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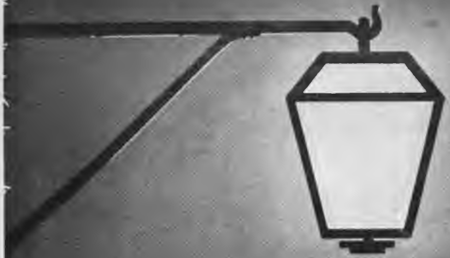

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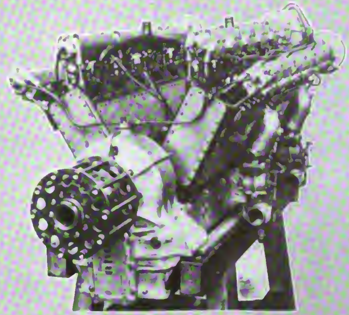

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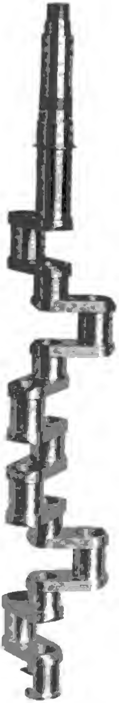

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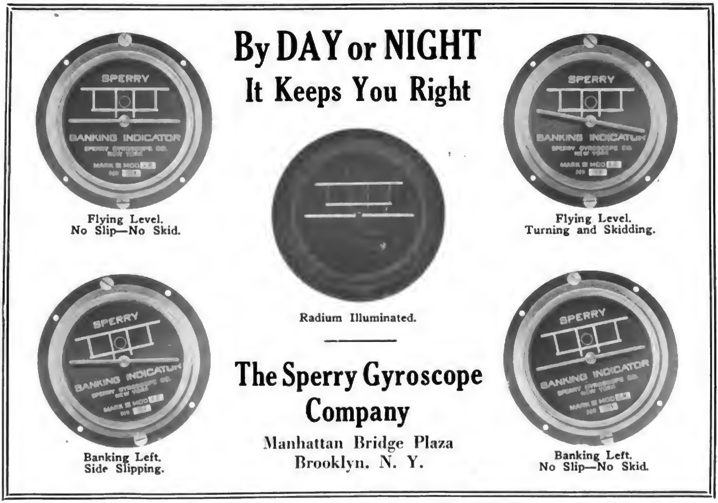

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Theory of Bomb Dropping*

When any object such as a bomb is allowed to fall from an aircraft in flight, it will not drop vertically, but its path will be a definite curved line. If the fall took place in a vacuum, the curve would be a parabola. The path, however, is influenced by various factors, particularly the resistance of the air, so that it becomes a distorted parabola or curve of higher order.

For the theoretical determination of this curve, we must know first, the velocity of the aircraft relative to the earth and the height from which the fall begins. Furthermore, we must know the form of the bomb, its weight, and the atmospheric pressure prevailing throughout the path of fall.

These many variables would make the computation very difficult if we did not make such assumptions as the following. The bomb is always freely released, and not thrown. The release always occurs at a moment when the aircraft is in exactly horizontal flight. Finally, the atmospheric pressure may be assumed constant.

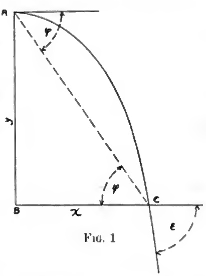

FIG. 1

Assume a particle of matter upon which a force acts, imparting a velocity v_0 making the angle α with the horizontal at the instant when the time $t = 0$. The effect of gravity is to impart an acceleration g in the vertical direction and the motion of the particle therefore becomes the resultant of a uniform and a uniformly accelerated velocity. The equation of the path becomes

$$y = x \tan \alpha + \frac{g}{2\,v_0^2} \cdot \frac{x^2}{\cos \alpha} \qquad (1)$$

This is the equation of a parabola and represents the path neglecting the resistance of the air. If now we wish to find the curve which the body will describe when freely released, set the angle α equal to zero on the supposition that the airplane was in horizontal flight. Equation (1) becomes

$$y = \frac{g}{2\,v_c^2} \cdot x^2 \qquad (2)$$

In Fig. 1 such a trajectory is represented where A is the point of release at the altitude y above the ground, and C, the point of striking the ground at a horizontal distance $x = BC$ from the point A.

The elements of interest of this trajectory follow:

1. The horizontal projection $BC = x$ of the parabola, i.e., the distance covered in a horizontal direction.
2. The final velocity v_e with which the projectile reaches the ground.
3. The time of fall.
4. The angle ε at which the projectile strikes.

From equation (2) we obtain for x

$$x = v_0 \sqrt{\frac{2\,y}{g}} \qquad (3)$$

The time of fall is obtained from

$$t = \sqrt{\frac{2}{g} \cdot y} \qquad (4)$$

From this equation it is evident that the time of fall (theoretically) is dependent only on the height and not on the velocity.

The final velocity is computed from the equation $v_e^2 = v_0^2 + g^2 t^2$ or substituting from (4)

$$v_e = \sqrt{v_0^2 + 2\,g\,y} \qquad (5)$$

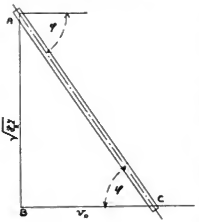

FIG. 2

The angle of fall is computed from

$$\tan \varepsilon = \frac{1}{v_0} \sqrt{2\,g\,y} \qquad (6)$$

If we designate the angle which the line AC makes with the horizontal as φ then it is easily seen that the bomb must be released at the instant when the target appears at this angle below the horizontal.

The angle is computed from the equation $\tan \varphi = y/x$. x is unknown. Substitute for x its value from equation (3) and

$$\tan \varphi = \frac{1}{v_0} \sqrt{\frac{g\,y}{2}} \qquad (7)$$

We have now expressed this sighting angle in terms of the velocity over the ground and the altitude.

If reality agreed with the above simple assumptions of a vacuum and a particle of matter, it would be easy to outline the general principles for a sighting mechanism for bomb dropping.

Equations (6) and (7) yield

$$\tan \varepsilon = 2 \tan \varphi \qquad (8)$$

From equation (7), the sighting mechanism could be arranged as shown in Fig. 2. We may write

$$\tan \varphi = \frac{\sqrt{\frac{g\,y}{2}}}{v_c}$$

The sighting tube AC is connected with the horizontal scale BC and the vertical scale AB, and A and C can be moved along their respective scales. Upon the horizontal scale, the different velocities of the aircraft are laid off. The vertical scale is proportional to the expression $\sqrt{\frac{g\,y}{2}}$ and the point A is accordingly set to the altitude of the machine.

For exact computations, other factors than the resistance of the air must be considered, particularly the form and weight of the projectile, and the decrease in density of the air with higher altitude. Up to heights of 500 to 600 meters and velocities of 35 m/sec., the effect of air resistance upon the horizontal distance x is very limited, and x can be computed by the equation (3).

In the dropping of bombs from an aircraft in flight, one is above everything else, dependent upon an exact knowledge of the altitude and velocity over the ground. It then becomes of importance to investigate the effect upon the accuracy of hitting of errors in the height or velocity or both.

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* By Ernst Heinkel. Abstracts from *Zeitschrift für Flugtechnik*, by E. I. Gayhart

If we designate the distance from point of aim to the point struck as dx, the error in height as dy and the error in velocity as dv_0, then differentiation of the equation

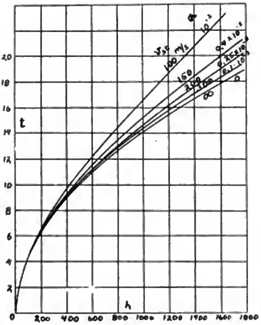


Fig. 3

$$x = \sqrt{\frac{2}{g}} \cdot v_0 \sqrt{y}$$

yields

$$\frac{dx}{x} = \frac{dv_0}{v_0} + \frac{dy}{2\ y}$$

If we write $dv_0 = av_0$; $dy = by$, then the factor a is the error in altitude and bx the error in velocity, and the above equation becomes

$$\frac{dx}{x} = a + \frac{b}{2}$$

or substituting for x, the value from a previous equation,

$$dx = \sqrt{\frac{2}{g}} \cdot v_0 \sqrt{y} \left(a + \frac{b}{2} \right) \qquad (9)$$

From the above equation it is to be seen that the error in hitting the target is proportional to the product of the velocity of the aircraft and the square root of its altitude.

A further source of error is to be found in the probability that at the moment of release, the airplane is not in exactly horizontal flight. The angle of deviation from the horizontal will be in general a small angle and the error from this source in comparison with the deviation from the other sources will be very small.

The problem of the resistance of the air appears at first sight to be very complicated. Really, the error due to the resistance of the air depends in addition to the altitude only on the relative velocity of the aircraft through the medium. One may understand the question better if the motion is considered as resolved in two components. A small error is introduced here, but with the limited horizontal velocity it is very small and does not affect the explanation of the problem.

Let us assume at first homogeneous atmosphere. We have two components of resistance to consider, the horizontal and the vertical. Both induce errors of opposite sign, so that the paradox may arise that because of resistance, the bomb will travel farther in the air than if in a vacuum.

First consider the resistance in the vertical direction. For the velocities of fall coming under consideration, we may assume with sufficient accuracy that the resistance varies as the square of the velocity.

If W equals the weight of the body, and α, a coefficient dependent upon its surface and form, then

$$\frac{W}{g} \cdot \frac{dv}{dt} = W - \alpha v^2$$

If we designate the limiting velocity where the resistance equals the weight and the acceleration zero, as v_{st} then $W = \alpha v_{st}^2$ and $\alpha = W v_{st}^{-2}$

For the sake of simplicity let us write

$$\frac{\alpha \cdot g}{W} = a = g v_{st}^{-2}$$

Development of the above equation yields

$$g \cdot \frac{dt}{dv} = \frac{1}{1 - \left(\frac{v}{v_{st}} \right)^2}$$

and through integration,

$$t = \frac{1}{g} \int \frac{dv}{1 - \left(\frac{v}{v_{st}} \right)^2} + C = \frac{v_{st}}{2g} \log \frac{v_{st} + v}{v_{st} - v}$$

Solving this equation for v gives

$$v = v_{st} \frac{e^{\frac{2gt}{v_{st}}} - 1}{e^{\frac{2gt}{v_{st}}} + 1}$$

Now $v = \frac{dh}{dt}$ and in consequence

$$h = v_{st} \int \frac{e^{\frac{2gt}{v_{st}}} - 1}{e^{\frac{2gt}{v_{st}}} + 1} dt + C$$

Integration gives

$$h = \frac{v_{st}^2}{g} \left\{ \log \left(e^{\frac{2gt}{v_{st}}} + 1 \right) - \frac{gt}{v_{st}} \right\} + C$$

Since for $t = 0, h = 0$,

$$C = \frac{v_{st}^2}{g} \log 2$$

$$\text{and } h = \frac{1}{a} \left\{ \log \frac{e^{2av_{st}t} + 1}{2} - a\, v_{st}\, t \right\}$$

In Fig. 3 curves of height against time are shown for various values of a and v_{st}, and for comparison, the curve is shown for fall in a vacuum.

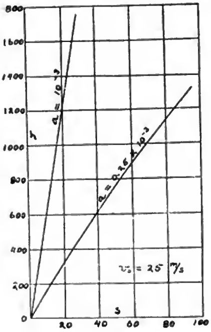


Fig. 4

We may assume that with a regular form, a for the horizontal component will have the same value. For the derivation of the horizontal resistance, we must consider that this resistance is a maximum at the moment of release and varies as the square of the velocity. It is clear that by this velocity is meant not the speed over the ground but the velocity through the medium. For the sake of simplicity, we can therefore state the problem as if the body fell from a fixed point and was driven by a wind of the same velocity.

If we designate the velocity of the aircraft through the air as v_0 then $\frac{W}{g}\frac{dv}{dt} = \alpha\,(v_0 - v)^2$ and $\frac{dv}{dt} = a\,(v_0 - v)^2$

$$\text{Then } t = \frac{1}{a}\int^{v} \frac{dv}{(v_0 - v)^2} = \frac{1}{a\,(v_0 - v)} + C$$

$$\text{and thence } t = \frac{1}{a\,(v_0 - v)} - \frac{1}{a\,v_0}$$

This equation solved for v gives

$$v = v_0 - \frac{1}{a\left(t + \frac{1}{a\,v_0}\right)}$$

Further, if we designate the error as s

$$ds = v_0\,dt - \frac{dt}{a\left(t + \frac{1}{a\,v_0}\right)}$$

and s becomes

$$s = v_0 t - \frac{1}{a}\log\,(1 + a\,v_0\,t)$$

This expression may he developed in a series. In Fig. 4 different values of s are shown in a diagram.

This value of s holds for machines of pusher type. For tractor machines the influence of the propeller is to be noted since the bomb receives a further acceleration to the rear in the first half second.

If we designate the velocity imparted by the propeller stream with A, then $v = v_0 - \frac{1}{a\left(t + \frac{1}{a(v_0 - A)}\right)}$

$$\text{and } s = v_0 t - \frac{1}{a}\log\left\{1 + a\,.\,t\;(v_0 - A)\right\}$$

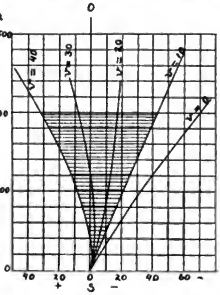


Fig. 5

We come now to an investigation as to the influence of the air resistance upon the sighting angle. If we designate the velocity over the ground by v, and the time of fall in vacuum by τ, then

$$\tan\varphi_1 = \frac{v\,.\,\tau}{h}$$

and in air filled space

$$\tan\varphi_2 = \frac{v\,.\,t - s}{h}$$

$$\text{and } \Delta\tan\varphi = \frac{v\;(\tau - t) + s}{h}$$

$$= \frac{v\;(\tau - t) + v_0\,t - \frac{1}{a}\log(1 + a\,v_0 t)}{h}$$

Observation of this equation shows that $\Delta\tan\varphi$ may be either negative or positive. It is negative when $vt - s > v\tau$. This case occurs when the expression $(v - v_0)$ is positive, i.e., when the aircraft flies with the wind.

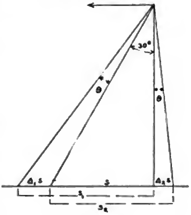


Fig. 6

In Fig. 5 the range of the error is shown graphically for different wind velocities. The shaded area shows the difference in error to be expected between a head wind and opposing wind of 15 meters per second.

Heretofore, the atmosphere has been considered as homogeneous. This is not the case since a falling body is continually passing from a rarer to a denser medium, so that the resistance av^2 reaches its full value a_0v^2 only at the surface of the earth. The following equation may be set up:

$$a = a_0\frac{b_m + b_{n\,(n-1)} + \ldots\ldots b_0}{b_0.(n+1)}$$

where a_0 holds for $h = 0$, and b equals the barometer reading for the respective heights. Here we have the relation

$$h_0 : h_{n-1} : \ldots\ldots\ldots h_1 = 1 : \left(\frac{n-1}{n}\right) : \ldots\ldots : \left(\frac{1}{n}\right)^2$$

Since, however, for an altitude of 1000 m., the quotient of $\frac{b_{1000}}{b_0}$ is always equal to 0.88 it follows that the influence of the change in density of the air may be neglected.

Of all errors which are made in dropping bombs, the most dangerous is that due to acceleration, and since it is often overlooked, let us examine it more closely.

Let v = velocity of the aircraft
h = altitude
s = horizontal distance covered
α = the derivative $\frac{dv}{dt}$ or acceleration

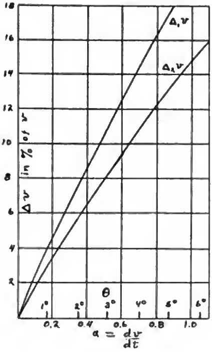


Fig. 7

The acceleration error manifests itself in several ways. In one way, in the measurement of the velocity, where the velocity is measured incorrectly, since, because of the acceleration, the direction of gravity is swung through an angle equal to $\tan^{-1}\frac{a}{g}$. Here, only the error that arises from this deviation should be discussed, and the incidental error in velocity which is usually small be considered later. For that reason, in the first case, only the relation should be given between incorrect measurement in consequence of acceleration and acceleration itself.

$$\Delta s = s - s' = h\left[\tan\varphi - \frac{\tan\varphi - \frac{a}{g}}{1 + \frac{a}{g}\cdot\tan\varphi}\right]$$

$$\tan\varphi = \frac{0.452\, v\sqrt{h}}{h} \quad (0.452 = \sqrt{2/g} = \sqrt{2/9.81})$$

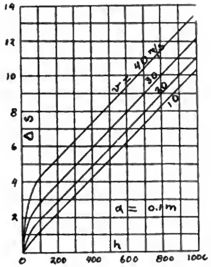


Fig. 8

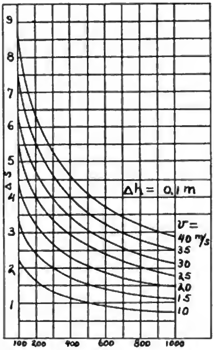


Fig. 10

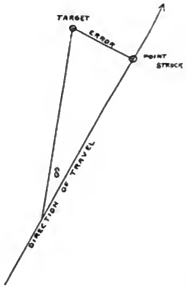


Fig. 9

Let t be the time required for an object to pass through an angle of 30°. (See Fig. 6).

$s = v_1 t_1 = v_2 t_2$, and $s_1 = v\, t_1$, $s_2 = v\, t_2$.

Thence $\Delta_1 s = \Delta_1 v\, t_1$ and $\Delta_2 s = \Delta_2 v\, t_2$.

In general $\Delta v = \frac{\Delta s}{t}$

$s = h \tan 30°$

$s_1 = h \tan (30° + \theta)$ and $s_2 = h\ (\tan 30° + \tan\theta)$ and thence $\Delta_1 s = h\ [\tan\ (30° + \theta) - \tan 30°]$, and $\Delta_2 s = h \tan\theta$, and further $t_1 = \frac{s_1}{v} = \frac{h \tan (30° + \theta)}{v}$

$$t_2 = \frac{s_2}{v} = \frac{h\ (\tan 30° + \tan\theta)}{v}$$

Substituting above

$$\Delta_1 v = v\left[1 - \frac{\tan 30°}{\tan\ (30° + \theta)}\right]$$

$$\Delta_1 v = \frac{v\,\frac{a}{g}}{\tan 30° + \frac{a}{g}}$$

This shows that the resulting error in velocity is dependent only on the velocity and its acceleration. In Fig. 7 this error is expressed in per cent of velocity for various accelerations.

An acceleration at the moment of release causes an error of some magnitude, since through it, the sighting angle φ is changed, because the direction of travel is turned through the angle $\tan^{-1}\frac{a}{g}$.

We have $s = h \tan\varphi$

$$\text{and } s' = h \tan\left(\varphi - \tan^{-1}\frac{a}{g}\right)$$

Substituting,

$$\Delta s = a\sqrt{h}\,\frac{h + 0.204\, v^2}{9.81\sqrt{h} + 0.452\, v\, .\, a}$$

This error for an acceleration of 0.1 meter is shown in Fig. 8.

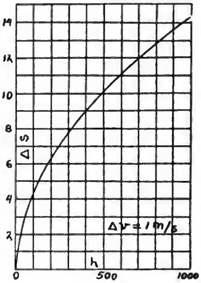


Fig. 11

The remaining errors are of less importance. They are the following:

1. The steering error of the pilot, the effect of which is shown in Fig. 9.

2. The errors induced by incorrect altitudes and velocitie shown in Figs. 10 and 11 and previonsly discussed.

Seaplane Float Construction

Second Installment

By Charles G. MacGregor

Curtiss Aeroplane and Motor Corp.

Deck Edge Stringers.—These are constructed similar to the chine stringers and are fitted to the deck edge of the flatbacks.

The materials used in the chine and deck edge stringers are ash, white oak, elm, mahogany.

Body Molds.—Where bent frame construction is used it is necessary to construct and erect temporary molds or forms to give the shape of the float. These are usually built of rough lumber similar to the keel mold, with stout straps across the back. Two types are shown in Figs. 10-11. The outside edge is cut to the inside of the fairing ribbands. They are set on top of the bottom stringers or keelsons after these are fixed in position. The fastenings used in the construction of the molds are wood screws (not wire nails), so that when the framework is completed they can be taken apart without breakage, removed from the interior of the framework and be reassembled for future use.

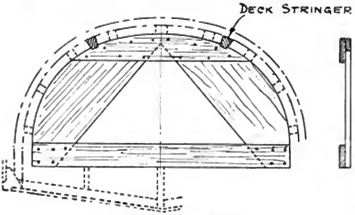


FIG. 10. OPEN MOLD

Deck Stringers.—All stringers which run inside the frames are fitted before the frames are bent over the ribbands, and are riveted to the frames where possible. Where intercostal stringers, or stringers fitted in short lengths between the frames, are fitted a ribband is let into the mold for this stringer to rest upon. This intercostal is only fitted after the frames are in place and is intended to prevent the planking from caving in or dishing where the frame spacing is wide (Fig. 7).

Materials used are ash, oak, elm, mahogany, Port Orford cedar, white pine and spruce.

Fairing Ribbands.—When the molds are set up on the roundback type of construction, temporary stringers or ribbands are laid longitudinally outside of these spaced about 4 in. apart. The frames are bent over these, then when the framework is complete and before the seam patterns are put on, the watertight bulkheads are put in, the ribbands being cut on each side of the bulkheads to allow this. The ribbands are fastened to each mold by one stout wood screw. Particular attention is paid to the "fairing" of the ribbands and the molds, so that there will be no bumps or hollows either transversely or longitudinally.

The method of fairing is as follows: Stand away from either end of the float a distance of about 3 or 4 ft. and glance along each ribband on the top edge. They should not show any unevenness. Should there be any appearance of a hollow, slacken the screw that holds it to the mold until this hollowness disappears, then drive a shim or wedge in between the ribband and the mold. If there should be any appearance of roundness, slacken the screw, or better still, take it out altogether, and saw or chisel a piece off the mold at this point, replace the screw and try again. Although all these ribbands may appear to be perfectly fair longitudinally, they may not be transversely. To test this bend several thin flat splines across the back of the float, tacked lightly to the ribbands. Now glance at these end on and look for any unevenness in their curvature, observing at the same time that each spline touches every ribband. It is important that they should be correct. The ribbands are not removed from the molds until each is overtaken by the planks as they are fitted.

The materials used are oak, ash, Oregon pine and yellow pine.

Frames.—These are of two types, viz., the steam bent and the solid frame. The former is used in the roundbacks (Fig. 5), and the latter on the flatbacks (Figs. 6-7). The heels of all bent frames or ribs, as they are sometimes called, are strapped or shod with light sheet copper, so that the rivet or screw fastening through the end will not split it. The nail heads in the copper are soldered so that they will not work loose and drop out. The corners on the inside of the curve of the frames are chamfered so as to eliminate to some extent the possibility of splitting when the wood is compressed with the bending. The frame is much stiffer when bent on edge than when it is bent on the flat. The thinnest frame that will hold a plank fastening is 3/8 in., but 7/16 in. more satisfactory for through riveting, because when the hole is drilled for the rivet almost a quarter of the cross section of the frame is cut away.

The built frames are made up in three parts (Fig. 8), fitted to the inside of the planking all around, and where seam battens are used, a notch is cut in the outer edge into which these fit. The names of the different parts of the frame are: The top piece is known as the beam, the side pieces are the side frames and the bottom piece is the floor. Each frame is built complete before it is set upon the keel and keel mold. The corner joint is mortised. The depth of the mortise does not exceed one-third of the thickness of the frame. At the corners the frames are made wider to make up for what is cut out of them by the deck and chine stringers and the mortise and also to give more surface at the joint for riveting. These joints are the weakest parts of the whole frame, so great care is taken to have them fit well and to see that the wood is not split when riveting the parts together. Figure 6 shows the joint. The best fastening for this part is the brass tubular rivet; it holds well and is easily riveted. Small knees of laminated wood are often used to brace the corners at the deck edge and chines (Fig. 8).

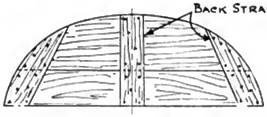


FIG. 11. SOLID MOLD

The materials used for bent frames are ash, oak and elm; for solid frames, ash, oak, mahogany and Spanish cedar.

Bulkheads.—Floats are divided into watertight compartments by transverse bulkheads or partitions; each bulkhead is strong enough to withstand the pressure against it from one side should the water fill the compartment on the other side of it. Each bulkhead is built of two layers of wood with cloth and marine glue or varnish between them. The grain of each skin crosses the other at an angle of 90 deg., and the skins are through fastened with solid brass or copper rivets. Along the edge of the bulkhead a hardwood frame is usually bent and through riveted to it. The bulkhead is also stiffened vertically and horizontally to prevent it from bulging under pressure; this also prevents straining of the edge fastenings. The bulkhead stiffeners are more efficient on edge than when placed on the flat. When the keelson or a stringer passes through the bulkhead the edge around the hole is supported by small strips or blocks, and are also necessary to keep this part watertight. Laminated wood under various trade names is used extensively for bulkheads, but unfortunately it is most difficult to obtain in this country. This wood is known as three-ply lamination or veneer.

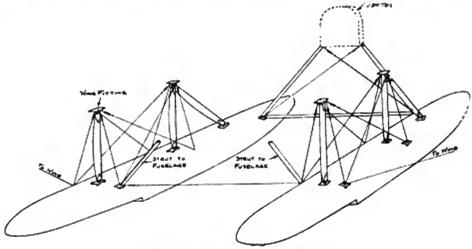


Fig. 12. Single Center Struts

The materials used besides the three-ply are mahogany, Spanish cedar, white cedar, white pine and spruce. Each plank does not exceed 5 in. in width and is not less than 1/16 in. thick.

Seam Strips.—The edges of all planks between the frames in the single skin construction must be supported in some way inside. The method adopted in float construction is by means of thin strips of hardwood run over the outside of the frames in a longitudinal direction, and placed so that each will come directly under the plank seam. These strips are fastened to each frame by one wood screw. The ends of each strip are notched into the stem and sternpost (Fig. 6).

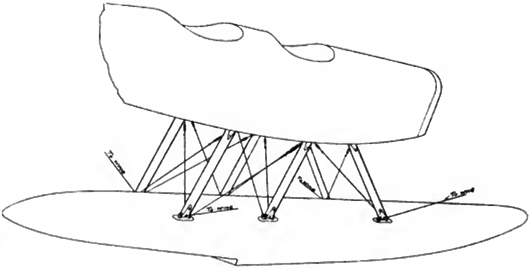


Fig. 13. Double Side Struts

Between these strips and on the outside edge of each frame is nailed a strip of wood called a liner. This is intended to fill in the space that would otherwise be left between the frame and the planking. These are usually made of pine. The materials used for the seam battens are oak, ash, elm, Spanish cedar and spruce.

Doublings.—Where a hole is cut through the deck or planking for handholes, struts or drainplugs, this part is weakened thereby, and is reinforced by what are known as doublings or blocking made of hardwood. These are attached to the frames, stringers, etc., where possible. They are fitted under the planking at the point where a fitting is attached or passes through, to make up sufficient thickness into which the fastenings are put. Doublings are illustrated in Fig. 7. The materials used for the doublings are ash, oak and mahogany.

Struts and Braces.—Here we have about the most difficult parts to construct in the whole float. This is a subject that is too extensive to enlarge upon in this article, because there are so many different methods of bracing or hanging the floats from the machine. So we had better limit this to a very brief outline of some of the commoner of these methods.

The continuation of the struts from the fuselage inside the float is distributed over the bottom structure, so that no strain due to landing comes on the topsides.

The outer struts are of three distinct types, as shown in Figs. 12, 13 and 14. Fig. 12, Single Center Struts; Fig. 13, Double Side Struts; Fig. 14, "A" Struts. These, of course, have diagonal wires and braces. The weight of the machine is distributed over the length of the float as much as possible. Two or three points of support are found to be sufficient, and are the most practicable in the floats in present day use. The foremost of these struts is known as the landing strut; it is set diagonally to resist the impacts of the water on the forward bottom of the float when taxi-ing or landing. The intermediate struts take the greatest load, and the rear struts take the least except when the machine pancakes or lands on the water tail first. From the point of attachment of these struts on the top of the float to the bottom keelsons, etc., other struts radiate inside, and are bolted to the metal clips inside, which have studs extending up through the deck to which the outside strut sockets are bolted. The heads of these studs are secured on the inside to prevent them from turning. All nuts on the outside are castellated.

In the use of steel struts inside, the point of attachment to the outer struts is kept as close as possible to the deck, and the inner struts as close up to the underside of the deck as possible so that there is not too much length left unsupported between these points. All strut pins

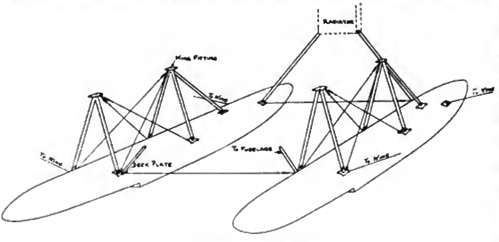


Fig. 14. "A" Struts

are fitted athwartship so that this will give a little latitude for setting up, and allow the machine to swing forward or backward for final and finer adjustment. The deckplates are fitted snugly around the strut ends where they project through the deck, so that the packing can be put between them and the deck and the strut, thus insuring a watertight connection.

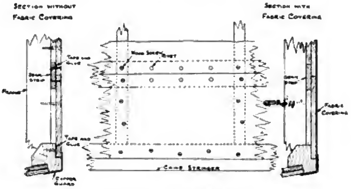


Fig. 15. Single Skin

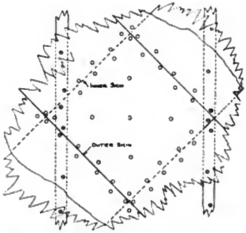


Fig. 17. Double Skin, Both Diagonal

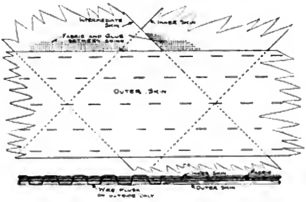


Fig. 19. Saunders' Sewn System

Brace wires are not attached to the deckplates unless the inside structure is sufficiently strong and well bolted to them to stand the pull that will come on the wire.

On the flatbacks where single struts are used the struts are attached to the sides or to a cross bulkhead (Fig. 6) and are braced from there down to the keelson and chine stringers inside. Between them a good husky brace is fitted to take compression, and on the outside a strap is fitted to prevent spreading.

With the two-point support (Fig. 6), the front struts act as landing and supporting members. The heel of the front is well forward and the heel of the rear strut is well aft, thus making each diagonally opposite.

The fitting of the interior float struts is one of the most difficult tasks undertaken by the float builder and it requires the most careful and skillful workmanship.

Planking.—There is a wide choice of methods of planking, but for good all around service the double skin diagonal is the most serviceable and durable.

Planks under 1/4 in. thick should never exceed 6 in. in width, and under 1/8 in. thick should never exceed 4 in. in width. If made greater than these widths they are very liable to check and split with the constant wetting and drying to which they are subjected under service conditions. Each plank is made in one length where possible, because each butt or joint is likely to be a weak point and means the addition of more weight to the float. When drilling holes for the fastenings in very thin planking a countersink is not necessary for the head of the fastening, as it draws in flush when it is riveted, particularly in the soft woods.

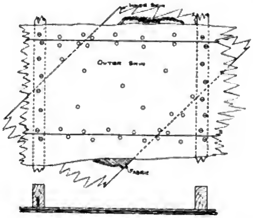


Fig. 16. Double Skin, Diagonal and Fore-and-Aft

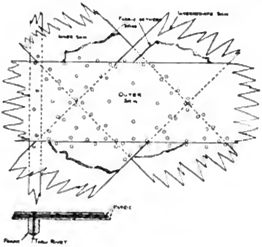


Fig. 18. Treble Skin

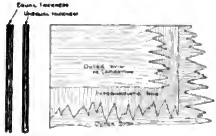


Fig. 20. Laminated Planking

The following are brief descriptions of some of the methods of planking most commonly used and proved to be very satisfactory in actual service. These are divided into groups for location, and are further subdivided into types, as follows:

GROUP 1. TOPSIDE PLANKING

A, Single Skin with Seam Strips.

B, Single Skin with Seam Strips—Fabric covered.

C, Double Skin Inner Diagonal; Outer Fore and Aft—Fabric between.

D, Double Skin Inner Diagonal; Outer Diagonally opposite—Fabric between.

E, Three Ply Laminated Wood.

GROUP 2. BOTTOM PLANKING

A, Single Skin with Seam Strips.

B, Double Skin Inner Skin Diagonal; Outer Skin Fore and Aft—Fabric between.

C, Double Skin Inner Skin Diagonal; Outer Skin Diagonally opposite—Fabric between.

D, Treble Skin, Inner Diagonal; Intermediate Diagonally opposite; Outer Fore and Aft—Fabric between all skins.

E, Three Ply Laminated Wood.

GROUP 3. BULKHEADS

A, Three Ply Laminated Wood.

B, Double Skin, Inner Diagonal; Outer Diagonally opposite—Fabric between.

Each group will now be treated individually and a brief description of the methods of planking, some of the troubles met with and what to look out for during the various operations:

GROUP 1. A, Single Skin with Seam Strips (Fig. 15). This method is used mostly on the topsides of the flatbacks without any covering other than the varnish or the paint. Most of the planks are straight or have a very slight curvature on the edges. Before the plank is fixed down a strip of tape or canvas saturated with marine glue or copal varnish is laid along the seam strips and rabbets below the edges of all planks, so as to make the joint watertight. The fastenings are spaced about 1½ in. apart on the seam strips and about 2 in. apart on the frames. They are not less than ¼ in. in from the edge of the plank. Fastenings are staggered where possible to avoid the chances of the wood splitting between them. When turning over the point of the rivet on the inside of the seam strip, each is turned to the right and left alternately for the same reason as stated above. The heads are filed flush when finishing the planking on the outside.

GROUP 1. B, Single Skin with Seam Strips, Fabric covered (Fig. 15). The only difference between this type of planking and the preceding one is that tape and glue are not used under the plank seams, as the fabric which is stretched over the outside of the planking keeps it all watertight. (See "Fabric Covering.")

GROUP 1. C, Double Skin Diagonal and Fore and Aft—Fabric between (Fig. 16). This method of planking is one of the strongest, and is used in both topside and bottom construction. The inner skin is in narrow strips about 4 in. wide, run from the keel out and forward to the chines at an angle of about 45 deg. These planks are fastened at intervals to the frames, etc. Sometimes they are run right across the bottom from chine to chine in one piece without being cut at the keel. When used in topsides construction they are laid continuously across the back from chine to chine. After the whole of the inner skin is completed, the fabric is then stretched over it as described under "Fabric Covering," and on it the seams of the under skin are marked with soft pencil, so that they can be easily located when drilling the holes for the fastenings on the outer skin. The outer skin runs in a longitudinal or fore and aft direction. The fastenings are arranged as shown in diagram. It will be noticed that they are staggered for both inner and outer skins. When drilling these holes for the fastenings, a metal jig is made for one frame space; this will work in for most of the frame spaces and will facilitate the work. The plank widths are kept as uniform as practicable, as this simplifies the work considerably. The bottom planking can quite profitably be built up on a form or mold the exact shape of the bottom of the float. On this form all keelsons, floors, etc., are marked. The inner skin is laid first and tacked at the outer ends only, which should be left about ½ in. longer than required. The fabric is stretched over, the outer skin laid, and all the fastenings are driven right through. The whole is then lifted off the mold, turned over and the ends of the rivets are turned down. The bottom planking is now placed on the upturned float bottom, fitted between chines and finally screw fastened to the floors and stringers. This method of building the bottom planking is found to be the best, because if the planking is built right on to the float bottom, trouble will be experienced in riveting the fastenings on the inside; in fact, in certain float construction it is almost impossible to build with rivet fastenings, and wood screws have to be resorted to for fastenings. When single topside planking is used, one or two of the planks are left off for access of the arm when riveting the bottom, and are screwed on when the planking is completed.

GROUPS 1-D, 2-C, 3-B, Double skin, both diagonal (Fig. 17). This method is much stronger than the foregoing on account of the grain of each crossing the other at about 90 deg. instead of 45 deg. Each layer is laid at about 45 deg. to the keel, and in opposite directions, so that the seams and grains cross. This method requires a very large number of fastenings; these are best arranged as shown in diagram. Only the very best lumber is used because the outer skin has no fabric covering, and is therefore exposed to the sun and weather. Great care is taken in the fitting of the seams on the outside. All planks are made about the same width and each plank is in one length.

GROUP 2. D, Treble Skin. (Fig. 18). This is seldom used in float construction, but is worth describing. It is very strong, but is much too heavy for the small size floats used at present. The method is the same as for double skin, both diagonal, with the addition of another layer of fabric and another layer of planking over all. The seams of the two inner skins are marked on the second or outer fabric. Each skin is very thin and therefore requires the most careful and skillful handling.

Another type of multi-skin construction is that shown in Fig. 19. The layers of planking are glued and ironed together with silk between, and then instead of being riveted they are sewn together with bronze wire. The wire is let in flush with the outside surface of the planking. No frames are required but longitudinal stringers are used to stiffen the hull. This makes a very neat and pretty job if properly and carefully executed, but is very expensive on account of the enormous amount of labor necessary.

GROUPS 1-E, 2-E, 3-A, Three Ply Laminated (Fig. 20). This material is made up in sheets about 60 x 42 in. It is made by gluing three layers of veneer together with waterproof glue under pressure. The inner layer is thicker than the outer skins, and sometimes they are made with all three skins equal in thickness. The grain of the inner runs opposite to the outer grains, thus making a very strong and rigid construction. It is invaluable in the construction of bulkheads and wing floats, planking and framing. The edges are liable to splinter if not protected, and in some inferior quality of this wood the layers blister and come apart, because of the glue giving way under ordinary service conditions.

Wood for Planking.—The most common varieties are mahogany, white cedar, white pine, spruce and Spanish cedar, when this latter is very carefully selected.

Fastenings.—For planking of the thickness used in these floats, the best fastenings are brass and copper rivets, in preference to wood screws; they hold better, can be driven in and have the ends turned over just as fast as a screw can be driven, and will not loosen up so readily. Wood screws, if driven too hard, will strip the thread in the wood and thereby render it useless as a fastening. On the other hand, screws can be used to more advantage than rivets for attaching the planking to frames and stringers.

The rivets are known as Canoe rivets, varying in length from 3/8 in. and upward. When long rivets are used through stringers, etc., a washer or burr is used to rivet the end over. The rivets through the planking and seam strips are spaced from 1½ to 2 in. apart; the thinner the wood the closer is the spacing. All wood screws used in planking have flat heads and are brass.

Fin Construction (Fig. 8).—Fins are sometimes required in some floats for stability or additional planing surface. The construction of these is very simple. Capstrips as used on the floors abreast the fins are extended out past the float side the required distance. The outer ends are notched into the fin edge stringer, which is usually made of ash, and the fin frames are also notched into the stringer at their lower ends, with the upper ends attached to the stringer at the float side. Over these the fin top planking is laid, usually in a fore-and-aft direction. Occasionally the fins are built merely as extensions of the bottom planking, thus acting as a planing board only and not as a watertight compartment. In this case the capstrips are covered with a thin plank and the outer edge is braced to the float side by short wood struts.

Fabric Covering.—The material used for the covering of floats either between the layers of planking or on the outside of the planking must be very strong, light but not too thin, with sufficient body in it to hold the varnish or marine glue with which it is saturated when being applied. Linen covering used on wings has been tried and found to be very suitable for the lighter type of floats, such as scout machines; but it requires proper and careful handling. For the larger floats a heavier material is recommended. Only the very best marine glue and the finest copal varnish are used for this work.

The finishing room, where varnishing, painting, gluing, etc., are done, is kept at an even temperature of not less than 65 deg. F. and not more than 80 deg. F. It is dry and kept well ventilated, so that the fumes are quickly carried off and the process of drying facilitated.

Before anything is applied to the planking, it is thoroughly and carefully sandpapered to a smooth finish and then brushed off. One thin coat of glue is then applied hot to the planking. When in use the hot glue is maintained at the proper temperature by keeping the glue pot surrounded with boiling water; or a branch pipe may be led from the steam pipe of the steam chest if this is convenient. The glue itself is never allowed to boil or it will become hard and brittle when cool; it must maintain its elasticity when set.

The fabric is stretched in one piece wherever possible, with plenty of allowance along the edges and on the ends for gripping by hand when stretching it over the float.

Before the fabric is stretched over, the float is given another coat of glue, sparingly but thoroughly applied over the first. This and the stretching are done very rapidly, as the fabric must be in place before the glue sets and hardens. The fabric is held about one foot above the float lengthwise and is pulled taut, then while being held out on each side at the middle the center is pressed down on top of the float, worked quickly along the top to the ends, the edges being kept up all around. The edges are then pulled down very tightly toward the chines, taking care to pull out all puckers in the fabric. Air pockets are forced out from under the fabric by rubbing firmly from the center towards the edges and ends. The fabric edges are secured by copper tacks to the chine stringers, spaced about 1 in. apart. When completely stretched, the whole of the fabric is gone over with a hot flatiron (an electric one preferred) heated sufficiently to draw the glue through to the surface. Care is taken not to overdo this ironing process, otherwise the glue would either harden or be drawn right out and thereby fail to hold the planking to the planking. The glue is allowed to dry thoroughly for at least two days in the same room before painting over. Three coats of paint are sufficient for the outside, the first one being thinner than the remainder.

When varnish is used in place of the glue, practically the same process is gone through with the exception that the first coat is applied to the bare planking just before the fabric is stretched over. The fabric is given previously one or two coats of varnish and applied to the float when still wet. Of course no ironing is necessary, but a coat of varnish is applied whenever the fabric is tacked down, so that it will penetrate the fabric and unite with the under coat. This is allowed to dry thoroughly before the paint is applied, and each coat is dried hard before the next is put on over it.

When the fabric is used between the skins of the double planking the same general method is followed. The fabric in this case is not stretched so tightly as the outside covering, and is tacked here and there to the inner planking to hold it in place while the outer skin is being built over.

If it is found necessary to make a seam, the lap is arranged so that the edge of the fabric in a transverse seam does not face forward on the outside. The after edge of the foremost piece laps over the foremost edge of the after piece.

(To be continued)

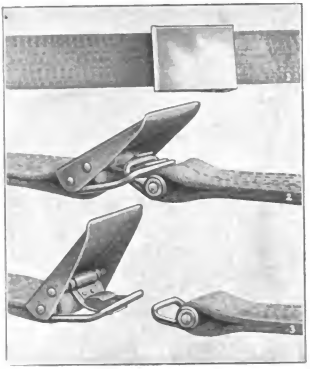
Hunting from Airplane Is Illegal

Hunting game with flying machines has been made illegal in North Carolina by a law prohibiting shooting water fowl on any of the waters of the States from an airplane.

The Tyler Safety Belt

The Tyler Safety Belt is of the quick release type, which instantly disengages the aviator at the pull of a toggle tongue buckle.

The cover, or front plate of the buckle, is hinged to the rear bar of the buckle frame and the tongue is attached to the cover in such a way that it rests on the front bar of the buckle when the cover is in the closed position. When the cover is opened a sufficient amount, the tongue is drawn off the front bar and drops through, positively disengaging the attached end of the belt.



THE TYLER SAFETY BELT

This belt is particularly adapted for use in airplanes, airships and kite-balloons, because it is easily fastened, locks positively, and cannot be interfered with by rust, ice, or heavy gloves, its operation being simple and instantaneous. Extra strain on the belt locks it more firmly, but does not interfere with its quick release feature.

New Propeller Shaping Machine

"The Will to Win" has caused many ingenious machines to be designed for the purpose of speeding up the production of struts, propellers, and other pieces of airplane wood-work.

Extreme accuracy as to weight, balance and form is vital, and must be taken into consideration by the designer of any wood-working machine to make it a success on airplane parts. Especially is this true of the two-, three-, or four-blade air screws. For this reason many of the standard wood-working machines have proven altogether inadequate to these exacting needs.

One of the latest machines to be offered to the manufacturers of Airplane Woodwork is a Special Propeller Shaping Machine which will handle the three- or four-bladed screws, as well as the two-bladed ones. It is built by the C. Mattison Machine Works, Beloit, Wis.

The Mattison Company has thoroughly studied the requirements of a propeller lathe, and with the co-operation of some of the biggest manufacturers in the country has perfected a machine which bids fair to revolutionize the production of propellers, on account of greatly increasing capacity, as well as of much smoother cutting. This works so close to finished size that very little hand work is necessary after the machining operation. The manufacturer of this lathe will be pleased to supply to any one interested in the manufacture of propellers any detailed information regarding the construction and operation of the machine.

The Metric System*

By V. P. Benedict

As we know it today, that is, as the French legal standard of weights and measures, the metric system is not the complete scheme as generally proposed. Devised in the troublous years of the Revolution, the intention was to wipe out the divisions of time which belonged to the Christian Era, and to alter the immemorial standard of 360 deg. as the division of the circle.

There were to be 400 deg. of 100 min. each by which to divide the world's circumference, and 360 days to the year, with ten hours of 100 min. to the day, and it was here that the scheme "bust up." The year declined the official request to drop its odd five days, and the French people declined with thanks the ten-hour day, although the authorities tried to enforce it by all sorts of penalties.

Having succeeded in retaining the staid 24-hr. division, the 400 deg. circle went by the board because it became unworkable, since mariners found themselves with a combination of 24 hr. and 400 deg. which, divided, yields a one-eyed fraction. So they reverted to the 360 deg. division, which gives four minutes of time to one degree of the earth's rotation, or 15 deg. of rotation for each hour.

Now, although these unworkable portions of the scheme were dropped, the remaining standards, which were based on the 400 deg. circle, were retained and adopted. Four hundred degrees of 100 min. gives 40,000 min., and one-thousandth of a minute was taken as the standard for a unit measure and was called a meter. Although, as a matter of fact, not strictly accurate, the meter was meant to be one forty-millionth part of the world's circumference.

To get a unit for volumetric capacity, one-tenth of a meter (about 4 in. English measure) was taken and cubed to give the liter, and taking a liter of pure water at 0 degrees temperature centigrade, the weight of it was obtained and divided into one thousand parts to give the standard unit of weight, which was called a gram.

The three units, the meter, the liter and the gram, are each uniformly divided and multiplied by tens, wherein lies all the simplicity of which adherents to the system so justifiably boast. To learn the whole system one has to memorize only about six prefixes beyond the three units, or nine items in all, and in commercial use only about half of these are called into service.

When the English schoolboy gets his 12 in. to the foot, three feet one yard business visualized, he is still in the dark when told that eight pints make one gallon, until he is shown the size of a pint or gallon measure, and so with his weights.

TABLE OF METRIC WEIGHTS AND MEASURES.

	$\frac{1}{1,000}$	$\frac{1}{100}$	$\frac{1}{10}$	UNIT.	10.	100.	1,000.
	Prefix to Unit.				Prefix to Unit.		
Length.	Milli ...	Centi ..	Deci ...	METER.	... Deca ...	Hecto ...	Kilo ...
Volume.				LITER.			
Weight.				GRAM.			

Here is a unit of length, one of volume, and one of weight, all correlated and each divided and multiplied uniformly, all of which, since the medium of correlation is pure water at a given temperature, can be corrected in any part of the world.

Now the ratio of specific gravity for any substance is taken on the basis of water at 0 degrees centigrade as the unit, and since the kilogram is the weight of a cubic decimeter of water, it is simply necessary to multiply the cubical contents of a given object in decimeters by the figure of specific gravity to obtain the weight in kilograms. Obviously, a saving over the English method where it is necessary to first find the weight of a cubic foot of water as an essential factor in the calculation, and then multiply this by the figure for specific gravity and then by the cubical contents in feet.

The metric system owes its simplicity mainly to the decimal basis on which all its sub-divisions are formed. Thus, if you have 752 mm. you have also 0.752 m., and 752 m. equals 0.752 km. With English measures, 752 in. is 62 ft. 8 in., or 20 yd. 2 ft. 8 in., and since our rules are in feet or yards, if you want to measure 752 in. you have first to do a bit of arithmetic.

Similarly if a French airplane contains 801 nuts of 22.0 g. each, the total weight (of nuts, not the plane) would be 17,622.0 g. Shift the decimal point three to the left (equal to dividing by 1000) and you get 17.622 kg., and 100 planes would contain similar nuts to the weight of 1762.2 kg., obtained by simply shifting the point.

Try it in English: 801 nuts of 1 oz. each equals 801 oz., or 50 lb. 1 oz., and you would need to work it out before you could weigh this amount. One hundred times the amount is 5006 lb. 4 oz. weighed as 2 tons 4 cwt. 2 qrs. 22 lb. 4 oz.

The pound weight was originally the weight of one pint of wheat, and the stone was the weight of a peck. The stone and peck to-day mean different values in different trades, and the whole is a most unholy chaos, to appreciate which it is only necessary to study the market reports of various commodities in the daily papers, which leave one as ignorant of what they ought to convey as do the official communiqués on airplane losses.

For we learn at school that 14 lb. make one stone, but the butcher does it with 8, which is 6 to the good, and the ounce avoirdupois can be got with lots less grains than the ounce troy. And a peck of peas or a pint of periwinkles are what you get for your money, and not what the table of weights and measures says they are.

Now whether we agree that the Metric System is preferable to our own, or, even if preferable, whether it is worth while going to the cost of changing (estimated at between 200 and 400 million pounds), the fact remains that many drawings of aero-parts and components, practically all those of Continental design and not a few of English, are dimensioned in meters and millimeters, so, those to whom these represent part of the daily grind will need to know how to tackle the problem of working in millimeters or, in the alternative, how to convert those same into English inches and fractions thereof (decimal fractions necessarily).

To handle metric-dimensioned parts satisfactorily, the best way undoubtedly is to have metric measuring instruments, get a grip of the metric system itself, which ought to take next to no time, and then go ahead metrically.

Instruments, however, are expensive and very difficult to obtain, so where these circumstances render the foregoing procedure unfeasible it becomes necessary to make conversions. For which purpose is printed herewith a Metric to English Conversion Table, which has been specially compiled to meet the particular requirements of the aircraft industry.

For small accurate parts such as engine components care must be taken to make conversions to at least the fifth place of decimals of an inch. The reason why being that the tolerance allowed is sometimes 0.00025 in. where close fits are required, and unless the fourth and fifth decimal places are accurately taken it is possible to start with an error in excess of the given allowance. When working in meters on wings and bodies two decimal places of an inch are more than sufficient.

This table is designed to be used for both meters (m.) and millimeters (mm.) since a "bus" is a big thing built up of a lot of little ones. The figures as they stand, with the point in the place shown, are for millimeters converted into inches. To convert meters into inches (which can readily be turned into feet, if necessary), the decimal point is to be taken as occuring three spaces later as shown by the slight gap between the figures.

To use the table for millimeters, the column headed .0 contains the English equivalent in inches of the even number of millimeters shown down the left side. These run from 1 to 40, and all tenths of a millimeter from 0.0 up to this figure are shown in the columns, progressing by one tenth at a time to the right. To convert a number of even mm. greater than 40, it is only necessary to adjust the decimal point as shown in the following examples:

For 6.0 mm. take the figure opposite 6 in col. headed 0.0 = 0.23622 in.

6.7 mm. take the figure opposite 6 in column headed 0.7 = 0.26378 in.

67.0 mm. take this latter figure and, since 67.0 is 10 times greater than 6.7, move the point one right, which multiplies the result by 10 to agree. = 2.6378 in.

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* Excerpt from *The Aeroplane*.

278.0 mm. take figure opposite 27 in col. 0.8 and move point one to right. = 10.9449 in.

2.78 mm. same figure, but point one to left (ten times less) = 0.10944 in.

275.0 mm. take 2.75 mm. and move the decimal point two places to right since it is 100 times less than the figure required;
or take 27.5 mm. and move the point one place to right.

The examples show how wide is the range of the table as it stands. Every likely conversion can be handled as in the higher figures, the small fractions are rare and unnecessary, and over 400 mm. anything more odd than 25's, 50's and 75's, which are covered by the table, are not likely to be met. It will frequently be found possible to get a double check on the conversion figure as in the case of the example given above of 275.0 mm., which can be taken either on 10 times the figure for 27.5 or 100 times the figure for 2.75.

For the conversion of metric measures, other than those of length, which are covered by the table, the subjoined schedule of conversion factors will be found of use, and will cover any need likely to arise. It is not always necessary to work to the full number of decimal places given, but the accuracy desired must govern the factor used.

Multiply	by	to convert into
Miles	1.6093	Kilometers.
Kilometers	0.62138	Miles.
Square inches	6.4517	Square Centimeters.
Square Centimeters	0.155	Square inches.
Square feet	0.092903	Square Meters.
Square Meters	10.7639	Square feet.
Cubic inches	16.387	Cubic Centimeters.
Cubic Centimeters	0.061025	Cubic inches.
Cubic feet	0.028317	Cubic Meters.
Cubic Meters	35.314	Cubic feet.
Cubic feet	28.317	Liters.
Liters	0.035315	Cubic feet.
Lbs.	0.45359	Kilograms.
Kilograms	2.2046	Lbs.
Ounces (avoir.)	28.348	Grams.
Grams	0.035275	Ounces.
Lbs. per Sq. inch	0.070308	Kilogs. per Sq. Centimeter.
Kilogs. per Sq. Centimeter	14.223	Lbs. per Sq. inch.
Lbs. per Sq. foot	4.8825	Kilogs. per Sq. Meter.
Kilogs. per Sq. Meter	0.20481	Lbs. per Sq. foot.

FRACTIONS

mm.	Inches.	mm.	Inches.
1/16	0.002461	9/16	0.022145
1/8	0.004921	5/8	0.024606
3/16	0.007382	11/16	0.027067
5/16	0.012303	13/16	0.031988
3/8	0.014764	7/8	0.034448
7/16	0.017224	15/16	0.036909

DECIMALS

mm.	Inches.	mm.	Inches.
0.005	0.000196	0.05	0.001968
0.01	0.000393	0.06	0.002362
0.02	0.000787	0.07	0.002755
0.03	0.001181	0.08	0.003149
0.04	0.001574	0.09	0.003543

METRIC CONVERSION TABLE. METERS AND MILLIMETERS INTO INCHES

BASIC FACTOR: 1 meter equals 39.370113 inches.

Meters or Millimeters.	0.0	0.1	0.2	0.25	0.3	0.04	0.5	0.6	0.7	0.75	0.8	0.9
0	.....	0.003 94	0.007 87	0.009 84	0.011 81	0.015 75	0.019 69	0.023 62	0.027 56	0.029 53	0.031 50	0.035 43
1	0.039 37	0.043 31	0.047 24	0.049 21	0.051 18	0.055 12	0.059 06	0.062 99	0.066 93	0.068 90	0.070 87	0.074 80
2	0.078 74	0.082 68	0.086 61	0.088 58	0.090 55	0.094 49	0.098 43	0.102 36	0.106 30	0.108 27	0.110 24	0.114 17
3	0.118 11	0.122 05	0.125 98	0.127 95	0.129 92	0.133 86	0.137 80	0.141 73	0.145 67	0.147 64	0.149 61	0.153 54
4	0.157 48	0.161 42	0.165 35	0.167 32	0.169 29	0.173 23	0.177 17	0.181 10	0.185 04	0.187 01	0.188 98	0.192 91
5	0.196 85	0.200 79	0.204 72	0.206 69	0.208 66	0.212 60	0.216 54	0.220 47	0.224 41	0.226 38	0.228 35	0.232 28
6	0.236 22	0.240 16	0.244 09	0.246 06	0.248 03	0.251 97	0.255 91	0.259 84	0.263 78	0.265 75	0.267 72	0.271 65
7	0.275 59	0.279 53	0.283 46	0.285 43	0.287 40	0.291 34	0.295 28	0.299 21	0.303 15	0.305 12	0.307 09	0.311 02
8	0.314 96	0.318 90	0.322 83	0.324 80	0.320 77	0.330 71	0.334 65	0.338 58	0.342 52	0.344 49	0.346 46	0.350 39
9	0.354 33	0.358 27	0.362 21	0.364 17	0.366 14	0.370 08	0.374 02	0.377 95	0.381 89	0.383 86	0.385 83	0.389 76
10	0.393 70	0.397 64	0.401 58	0.403 54	0.405 51	0.409 45	0.413 39	0.417 32	0.421 26	0.423 23	0.425 20	0.429 13
11	0.433 07	0.437 01	0.440 95	0.442 91	0.444 88	0.448 82	0.452 76	0.456 69	0.460 63	0.462 60	0.464 57	0.468 50
12	0.472 44	0.476 38	0.480 32	0.482 28	0.484 25	0.488 19	0.492 13	0.496 06	0.500 00	0.501 96	0.503 94	0.507 87
13	0.511 81	0.515 75	0.519 69	0.521 65	0.523 62	0.527 56	0.531 50	0.535 43	0.539 37	0.541 34	0.543 31	0.547 24
14	0.551 18	0.555 12	0.559 06	0.561 02	0.562 99	0.566 93	0.570 87	0.574 80	0.578 74	0.580 71	0.582 68	0.586 61
15	0.590 55	0.594 49	0.598 43	0.600 39	0.602 36	0.606 30	0.010 24	0.614 17	0.618 11	0.620 08	0.622 05	0.625 98
16	0.629 92	0.633 86	0.637 80	0.639 76	0.611 73	0.645 67	0.649 61	0.653 54	0.657 48	0.059 45	0.661 42	0.665 35
17	0.669 29	0.673 23	0.077 17	**0.679 13**	**0.681 10**	0.685 64	0.688 98	0.692 91	0.696 85	0.698 82	0.700 77	0.704 73
18	0.708 66	0.712 60	0.716 54	0.718 50	0.720 47	0.724 41	0.728 35	0.732 28	0.736 22	0.738 19	0.740 16	0.744 10
19	0.748 03	0.751 97	0.755 91	0.757 87	0.759 84	0.763 78	0.767 72	0.771 65	0.775.59	0.777 56	0.779 53	0.783 47
20	0.787 40	0.791 34	0.795 28	0.797 24	0.799 21	0.803 15	0.807.09	0.811 02	0.814 96	0.816 93	0.818 90	0.822 84
21	0.826 77	0.830 71	0.834 65	0.836 01	0.838 58	0.842 52	0.846 46	0.859 39	0.854 33	0.856.30	0.858 27	0.862 21
22	0.855 14	0.870 08	0.874 02	0.875 98	0.877 95	0.881 89	0.885 83	0.889 76	0.893 70	0.895 67	0.897 64	0.901 58
23	0.905 51	0.909 45	0.913 39	0.915 35	0.917 32	0.921 26	0.925 20	0.929 13	0.933 07	0.935 04	0.937 01	0.940 95
24	0.944 88	0.848 82	0.952 76	0.954 72	0.956 69	0.960 63	0.964 57	0.968 50	0.972 44	0.974 41	0.976 38	0.980 32
25	0.984 25	0.988 19	0.992 13	0.994 09	0.996 06	1.000 00	1.003 94	1.007 87	1.011 81	1.013 78	1.015 75	1.019 69
26	1.023 62	1.027 56	1.031 50	1.033 46	1.035 43	1.039 37	1.043 31	1.047 25	1.051 18	1.053 15	1.055 12	1.059 06
27	1.062 99	1.066 93	1.070 87	1.072 83	1.074 80	1.078 74	1.082 68	1.086 62	1.090 55	1.092 52	1.094 49	1.098 43
28	1.102 36	1.106 30	1.110 24	1.112 20	1.114 17	1.118 11	1.122 05	1.125 99	1.129 92	1.131 89	1.133 86	1.137 80
29	1.141 73	1.145 07	1.149 61	1.151 57	1.153 54	1.157 48	1.161 42	1.165 36	1.109 29	1.171 26	1.173 23	1.177 17
30	1.181 10	1.185 04	1.188 98	1.190 94	1.192 91	1.196 85	1.200 79	1.204 73	1.208 66	1.210 63	1.212 60	1.216 54
31	1.220 47	1.224 41	1.228 35	1.230 31	1.232 28	1.236 22	1.240 16	1.244 10	1.248 03	1.250 00	1.251 97	1.255 91
32	1.259 84	1.263 78	1.267 72	1.269 68	1.271 65	1.275 59	1.279 53	1.283 47	1.287 40	1.289 37	1.291 34	1.295 28
33	1.299 21	1.303 15	1.307 09	1.309 05	1.311 02	1.314 96	1.318 90	1.322 84	1.326 77	1.328 74	1.330 71	1.334 65
34	1.338 58	1.342 52	1.346 46	1.348 42	1.350 39	1.354 33	1.358 27	1.362 21	1.366 14	1.368 11	1.370 08	1.374 02
35	1.377 95	1.381 89	1.385 83	1.387 79	1.389 76	1.393 70	1.397 64	1.401 58	1.405 51	1.407 48	1.409 45	1.413 39
36	1.417 32	1.421 26	1.425 20	1.427 16	1.429 14	1.433 07	1.437 01	1.440 95	1.414 88	1.446 85	1.448 82	1.452 76
37	1.456 69	1.460 63	1.464 57	1.466 53	1.468 51	1.472 44	1.476 38	1.480 32	1.484 25	1.486 22	1.488 19	1.492 13
38	1.496 06	1.500 00	1.503 94	1.505 90	1.507 88	1.511 81	1.515 75	1.519 69	1.523 62	1.525 59	1.527 56	1.531 50
39	1.535 43	1.539 37	1.543 31	1.545 27	1.507 25	1.551 18	1.555 12	1.559 06	1.562 99	1.564 96	1.566 93	1.570 87
40	1.574 80	0.1	0.2	0.25	0.3	0.4	0.5	0.6	0.7	0.75	0.8	0.9

Book Review

THE PRINCIPLES OF AEROGRAPHY, by Prof. Alexander McAdie. (Rand, McNally & Co. $3.00. Pp. 318.)

With the large increase in the number of men engaged in the flying of airplanes and dirigible balloons, the science of meteorology has assumed a position of considerable interest and importance. It is important that the aviator know something of the cause of certain atmospheric phenomena. At ground schools, where future aviators are given preliminary training for their work, considerable time is devoted to the study of this subject.

The number of books treating with meteorology is not large, and very few of them can be considered up to date. One of the latest is a book entitled "The Principles of Aerography," by Prof. Alexander McAdie, director of Blue Hill Observatory. The information contained in this book is given in a convenient and condensed form.

Professor McAdie's book has many features not to be found in other text-books on the subject. Among these are: results of recent aerological investigations, classification of clouds according to origin rather than appearance, studies of air flow at different levels and the gradient wind, studies of ice storms, snow-falls equivalent and charts for aviators.

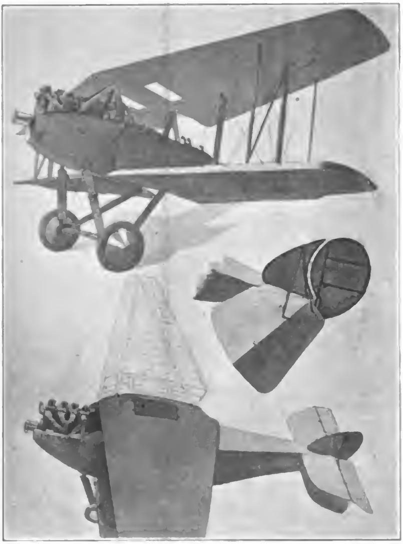
There is a chapter devoted to the forecasting of storms and another dealing with winds. A highly interesting chapter is the one devoted to the subject of water vapor in the atmosphere, containing information on the measurement of cloud altitudes, classification of clouds, distribution and various types of clouds, wave motion in the air shown by cloud undulations and the value of clouds in the forecasting of weather changes; all of which is of interest to the aviator and aeronaut. Formation of fog, thunderstorm phenomena and rainfall are also considered.

Much information is given in the form of pictures, diagrams and charts. The cloud pictures shown, several of which were taken by Professor McAdie, are very good.

The book has about 110 illustrations, charts, and diagrams, and a very complete index, which further enhance the value of this comprehensive work.

The 230 Horsepower Ago Fighting Biplane*

As regards its general lines, the Ago fighting biplane is of a strikingly unusual appearance, due mainly to the fact that the wings are tapered very pronouncedly from root to tip. This feature, so unusual in any modern machine, is decidedly disadvantageous from the manufacturing viewpoint, since it entails the separate construction of one half the ribs, no two of which are alike in one wing. The reasons which prompted the designers of the Ago to adopt the tapering wing shape become, however, evident upon examination of the interplane bracing system.



Perspective Views of the Ago Fighting Biplane

Unlike on most German two-seater biplanes, which have two pairs of interplane struts on either side of the body, the Ago carries only one pair at either tip. In place of the conventional inner pair of struts there is only a single solid wire running from the upper front spar to the lower front spar, while no lift or landing wires occur between them. By doing away with the inner front interplane struts a considerable arc of fire is afforded to the gun mounted *en barbette* on the after cockpit, which can thus fire both forward and backward. Owing to the backward slope of the leading edge of the wings the outer interplane struts are farther back than they would be in a machine with straight wings and also, owing to the taper, closer together and therefore obstructing the field to a smaller extent. The small chord at the wing tips also localizes the travel of the center of pressure, so that the absence of an inner front bracing appears as a less serious defect than would seem at first sight. The rear spars are, moreover, braced by inner interplane struts, one being fitted on either side of the body, in the wake of the vertical wire connecting the front spars.

The wing spars are of an interesting construction, and their section is shown in the accompanying sketches. The two flanges are glued to thin webs about (5 mm.) the whole being wrapped in fabric. No tacks or screws are employed for securing the webs to the flanges, gluing and wrapping being apparently relied upon to be sufficient for the purpose. At the points where the ribs occur a three-ply distance piece is glued into the hollow spar. The rear spar, which was of slightly smaller dimensions than the front spar, was different in that its upper flange had been spindled out, otherwise the two spars were similar, also in that in both the top flange was not quite so thin as the bottom flange. The spars were constructed of what appeared to be some kind of pine, possibly Dantzig.

Where the bolt, serving as an anchorage for the wire running to the top plane occurred, the spar was strengthened by a packing piece of peculiar form. This is shown in some of our sketches, which will, we hope, help to explain it. It will be seen that the saw cuts in the ends of this distance piece leave four tapering ends, which would have the effect of cantilever beams proportioned to carry an end load, the latter being considered as the lateral load on the spar at this point. It is possible that the shape of this piece is simply the result of an attempt at stiffening the spar for a considerable distance on each side of the joint, without carrying too much weight. The vertical bolt, to which reference was made above, is not passed through the spar itself, but through an additional stiffening piece glued to the front face of the spar. Two horizontal bolts run through the spar, and securing on its rear face the compression strut for the internal wing bracing, are the only attachment, apart from the glue, of this packing piece to the spar proper. This arrangement is obviously weak, for a pull on the interplane wire must result in a tendency to twist the spar, placed, as it is, so far from its vertical neutral axis.

The outer interplane struts are streamline steel tubes, with a diagonal tube welded to them. In addition to this diagonal tube there is a wire running diagonally in the opposite direction, probably to ensure that the welded joints of the struts shall not have to work in tension under the changes in load, caused by the travel of the centre of pressure.

Constructionally, the ribs are of the usual I-section, with webs which appear to be made of poplar, and with flanges of ash. In between the spars the webs are lightened by cutting out in the usual way. The leading edge is of pine, of a rounded V section between ribs, but left solid where the ribs are attached to it. The trailing edge is a thin lath about 1 in. wide by 3/16 in. thick.

Successive ribs are of different depth, as well as chord, owing to the fact that the spars, in addition to their convergence, are of varying depth from root to tip. Judging from the way in which the spars taper, it would appear that the end ribs are not of quite the same section as the inner ones.

The ailerons, which have their tips at a slightly smaller angle of incidence than that of the inner ends, are hinged to a false spar slightly to the rear of the rear main spar. The leading edge of the ailerons is in the form of a steel tube, partly enclosing which, and at some distance from it, is a strip of three-ply wood, which provides the requisite depth of the leading edge of the aileron. A short strip of steel, quite thin, is bent around the tube, its two ends projecting back and being accommodated in a slot in the rib. This strip is then soldered—and probably pinned, although this could not be ascertained—to the tubular leading edge.

Half-way between consecutive ribs small distance pieces are tacked to the three-ply, having their free ends abutting on the surface of the tube. Another sketch shows the tube to which the inter-aileron strut is attached. The crank lever of the upper aileron has a forward projection curving up over the false spar, and dipping down in an opening between two ribs. To this projection is attached one of the aileron control cables, which runs over a pulley in the lower spar and, internally, in the lower wing to the cranks on the longitudinal rocking shaft. In plain view, the aileron crank lever is bent and runs through a rib, the clip attaching it to the inner aileron strut being similar to that of the lower aileron shown in the sketch. From this aileron crank a cable passes over another pulley in the same casing as that of the first, and hence through the lower plane to the controls. It will thus be seen that both elevating and depressing the aileron is a positive movement.

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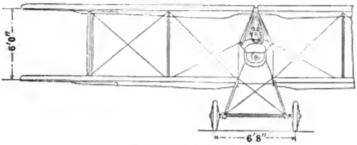
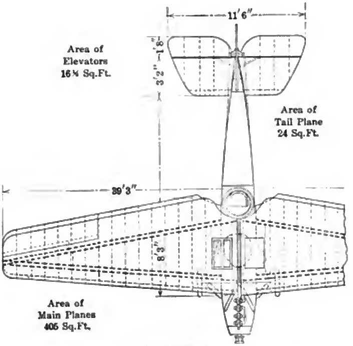
* Excerpt from *Flight*.



Front Elevation

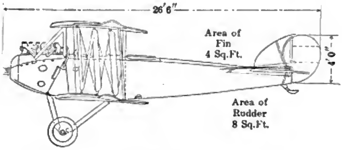

11'6"
1'8"
3'2"
Area of Elevators 16¼ Sq.Ft.
Area of Tail Plane 24 Sq.Ft.
39'3"
8'3"
Area of Main Planes 405 Sq.Ft.

Plan View

The tubular leading edge of the ailerons is supported by a small bearing at the inner end, and by two clips of steel bent over the tube and bolted to the false spar at certain intervals. Thus each aileron is carried in three bearings. The outer end of the leading edge of the aileron is free. A fact which at once impresses itself on one in looking at the lateral control of the Ago, is that the point from which the aileron is actuated is very near its inner end, leaving a very large amount of the aileron area outside, a fact which must give rise to considerable twisting stresses.

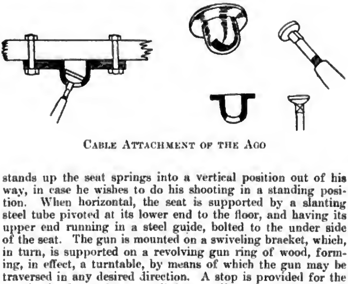
The body which is, as in the majority of German airplanes of very roomy proportions, as regards occupants' accommodation, is covered with fabric, except the front around the engine, which is covered in with three-ply, as is the floor of the body from the stern to the gunner's (rear) cockpit. From there to the nose the floor is three-ply, covered with aluminum. In section the body is rectangular, a light and comparatively flat structure forming a turtle back over the top of the main body framework. This turtle back is built up as a separate unit, and is easily detachable by means of a neat and very simple clip.

The four longerons, which are of square section, are pine, from the rear cockpit to the stern, while in front they are of ash. The struts are steel tubes, and the solid wire bracing is attached to the struts in the manner shown in one of the accompanying sketches. A small socket, apparently machined out of the solid steel bar, has holes drilled in its edges, through which the bracing wires pass. This socket is slipped over the end of the tube, which has small dents in its end to give more room for the loop of the wire, and the socket, with its strut, is secured to the longeron by a bolt passing through it, with the nut and a spring washer inside the socket, as shown in section in one of our sketches.



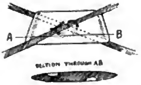
Side Elevation

In front, the body bracing is in the form of diagonal steel tubes, no wires being employed. The rear cockpit is occupied by the machine gunner, who is seated on a small seat built up of a framework of steel tubing, over which is stretched canvas. This seat is so hinged and sprung that immediately the gunner stands up the seat springs into a vertical position out of his way, in case he wishes to do his shooting in a standing position. When horizontal, the seat is supported by a slanting steel tube pivoted at its lower end to the floor, and having its upper end running in a steel guide, bolted to the under side of the seat. The gun is mounted on a swiveling bracket, which, in turn, is supported on a revolving gun ring of wood, forming, in effect, a turntable, by means of which the gun may be traversed in any desired direction. A stop is provided for the gun in the form of two small frames clipped to the rear legs of the cabane, which prevents the gun barrel from traveling too far inboard.

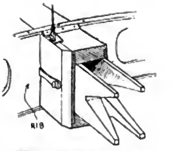


Cable Attachment of the Ago

The pilot's seat, which is in the front cockpit, is placed on top of the main gasoline tank resting on the floor of the body.



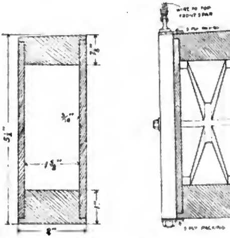
Distance Piece of Internal Wing Bracing



Wire Attachment on Front Spar

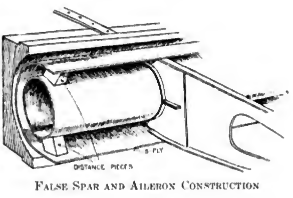
A service gasoline tank is carried in and mounted flush with the top plane just to the left of the cabane. In the corresponding opening in the upper right-hand wing is carried the radiator; the water and gasoline is led through the right and left cabane legs respectively, thus saving a certain amount of piping which would otherwise be exposed to the air.

The controls are of the usual German type, with a vertical lever terminating at the top in a double-handled grip and mounted, via a universal joint, on a longitudinal rocking shaft, having at its rear end crank levers for the attachment of the aileron cables. On the machine in question no guns are mounted, but from the various fittings it appeared that there were at one time two machine guns mounted above the engine, and with the usual interrupting gear for clearing the propeller blades.



Cross Section of Front Spar Near Body (Left), and at Point of Attachment of Internal Wing Bracing (Right)

The 230 hp. Benz engine is mounted on two longitudinal bearers, which are in turn supported from the body by three direct supports; at the rear by a sloping panel of ply-wood; in the middle by tubes sloping up from the junction of the rear panel to the lower longerons, and at the front by another panel of ply-wood; this is a vertical one.

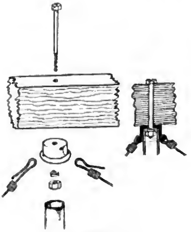


False Spar and Aileron Construction

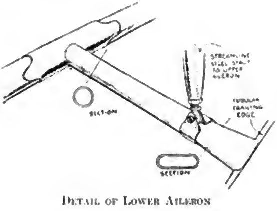
In addition to these direct supports, the engine mounting is further braced by tubes to the upper longerons, and by diagonal tubes from top to bottom longerons. The oil tank, which is comparatively small, is carried under the engine housing on the right-hand side of the crank chamber.

The tail planes are similar in construction to that of the main planes, the same form of box spars being employed. The stabilizing plane is brought to the same level as the top of the body by dropping the lower longerons somewhat after the fashion of the old Deperdussin monoplanes. A clip secures the front spar of the tail plane to the longerons, while the rear spar is attached by means of a sliding clip arrangement, which allows (not during flight) of adjusting the angle of incidence of the tail. The vertical fin, which is of tubular construction, is mounted on and moves with the tail plane. No very great amount of adjustment is, therefore, possible, as a comparatively small movement of the rear spar of the tail plane brings the rudder against the edge of the cut out portion of the fin. The rudder, which is also built of steel tubes, has no support above the stern of the body, this being difficult to obtain in conjunction with the adjustable fin. The result is that the rudder is very much overhung and does not look any too strong for its work.

The under carriage is of the Vee type, built of steel tubes stream-lined with wooden fairings. The axle is slung, by means of rubber band, from the apex of the Vee, and is enclosed in a stream-lined casing of aluminum. The lower half of this casing is bolted to the transverse tube of the chassis, while the upper half is hinged along this transverse tube and is allowed to move its trailing edge up and down, according to the travel of the axle. A stout wooden tail skid, sprung by means of rubber chord inside the body, has at its outer end a metal protector in the form of a hemispherical bowl bolted to the end of the skid.



Body Fitting



Detail of Lower Aileron

S. A. E. Election

The Society of Automotive Engineers elected at its annual meeting the following officers for the ensuing year:

President—C. F. Kettering, Dayton, Ohio; *Vice-Presidents*—David Beecroft, New York City; C. C. Hinkley, Detroit; George H. Houston, New York City; Major Fred Glover, Washington; Henry R. Sutphen, New York City, and H. R. Brate, Lakemont, N. Y. *Members of the Council*—Charles S. Crawford, Charles M. Manly and J. V. Whitbeck; *Treasurer*—Charles B. Whittelsey.

Exports of Airplanes

During October, 1917, the exports of airplanes from the United States were valued at $1,028,000 against those for the same month of the previous year, which were valued at $123,000. For the ten months ending October, 1917, the exports of airplanes were valued at $5,235,000. The exports for the same period of the previous year amounted to $3,492,000.

Development and Progress in Aviation Engines*

By the Late Henry Souther

The art of aviation and the industry of building airplanes, engines, and accessories, to meet the demands of the art, is now going forward with wonderful strides. Commercial usage as well as war usage begins to attract the attention of the aeronautical engineer.

It is interesting to refer back a few years to the *Journal of The Franklin Institute*, dated Oct., 1910, and learn to appreciate the rapidity of change in the Art. Reference is made therein to a "useful load of 450 lb., including three passengers." This weight is the equivalent of about 75 gal. of gasoline, which is less than the amount required for four hours' flight of a two-passenger airplane of recent design and construction. Nearly twice this volume of gasoline is now carried, with two passengers and 150 lb. additional useful load.

Reference is made to airplane flying altitude: "Prominent aviators who undertake a cross-country flight select their course with care and maintain a very high altitude." "Lambert, who ordinarily does not seek high altitudes, in soaring over Paris, was obliged to ascend to a height of more than 1600 ft." In the war zone danger is now imminent below 16,000 ft. altitude. Much flying is necessary at greater altitudes. Peaceful cross-country flying is done at what are now called safe altitudes of from 3000 to 7000 ft. From such altitudes it is probable that a suitable landing area could be reached in case of need. With a "dead" engine the angle of glide is about six to one. This means that a six miles radius circle is available for a choice of landing from an altitude of one mile.

Duration of flight is referred to as follows: "Present-day flights are no longer measured in minutes." "The hour has been exceeded by many pilots." "The airplane will enter the field of touring." All this and more is now true after a period of six years.

Aviation engine weight per horsepower delivered has not changed much; but engines are more reliable, more efficient and stronger, and heavier where experience has taught the need. The term "weight per horsepower" is a loose one. There are many parts that may or may not be considered as a part of the engine of the power plants to be included in the weight. Some twenty-eight or thirty items have been found in this doubtful class. The weight of gasoline and oil consumed per hour is figured by some as an element of engine weight. It does influence the design of the airplane as a whole. It must be known. For example, the rotary, air-cooled engine, although very light, about two pounds per horsepower, is outclassed by heavier engines if the airplane must fly more than three hours. The rotary engine consumes too much gasoline and oil per horsepower-hour for long flight.

Broadly speaking, it may be said that the weight may safely vary from two to five pounds per horsepower. This will include the weight of magneto, carburetor, and wiring. Other elements of the power plant, such as water, water piping, oil in the engine and the propeller, are not included.

An engine which ranks very high for speed, climbing and endurance weighs 2.4 lb. per horsepower. This engine is high strung and delicate, but very effective. Many types of engines are in practical use. There is an ever-changing idea as to the proper function for each type, and a constant shifting of opinion of one engine to another of any given type, as to the superiority. Any improvement of design, material, or workmanship may result in temporary superiority. Competition in this matter is keen. All sorts of daring expedients are tried under war pressure. The result is rapid change and rapid improvement.

The future one may not predict. The probable status six months hence is only speculation. It is certain that greater horsepowers are appearing for all types and sizes of airplanes. The result is increased speed, climb, and load-carrying capacity. There seems to be no limit to this increase except that imposed by lack of experience. This lack is being made good very rapidly just now by war conditions.

About a year ago it was thought that no more than 90 hp. could be obtained from a radial rotary, air-cooled engine. One-third more has been obtained, and nearly double is now planned.

Similar improvement is being brought about, by experience, in other engines. An eight-cylinder, V-type engine now develops consistently 210 hp. Six months ago it did not function as consistently at 180 hp. There has been no radical change of design or size.

Experience has been the teacher. No internal-combustion engine of new and extreme design can be brought to a condition of practical excellence in less than a year, and often two years. Yet partially developed engines must be purchased and used or there will never be complete development.

The next and very important step is the development of organizations that can really manufacture an aviation engine or airplane, rather than build a few models, or a dozen or two nearly alike. This is a task that will easily occupy another year of consistent endeavor. At least one aviation manufacturing organization finds itself in this state of development. The building nucleus of men must be expanded into a manufacturing force. The product must be adapted to practical methods of manufacture, to existing tools, and standards, so far as possible. Otherwise no quantity production may be expected.

This has been proved many times in other industries. The aircraft industry is not different. In fact, it is astonishingly similar to the motor-car industry as found during its beginning and early growth.

Perfection would be approached by having each plant producing aviation material, as engines or airplanes, so organized and equipped as to manufacture one type only and do that well. This condition will be brought about by a consistent demand or in response to a pressing need. A proper foundation for such a development is now being laid by the same engineering body that assisted in the amazing growth of the motor-car industry—The Society of Automotive Engineers (recently Automobile, but expanded to include closely-allied industries, of which aviation is one). Its standards and engineering practices will creep into the new industry as they did into the older one.

It is difficult to discuss aviation without mentioning the Wright Brothers. They developed much knowledge of flying without an engine by gliding experiments, and then sought an engine.

At the outset of the automobile industry the power estimated as necessary was too small. Practical tests indicated that three horsepower would suffice, with a generous factor of safety. History repeated itself. Orville Wright recently stated that an eight-horsepower engine was figured as necessary. Such an engine, not to exceed 200 lb. in weight, was sought in the open market. This occurred in 1903, and none was offered that was worth considering.

The Wrights then built a four-cylinder 4- x 4-in. engine that did weigh less than 200 lb. This engine developed 12 hp. and actually flew an airplane. This engine was followed soon by a much better one that developed 30 to 35 hp. It was simple in the extreme degree. A jet nozzle in the intake pipe served to atomize the gasoline; the ignition was a low-tension system; the water jackets were of sheet aluminum, the crank shaft very small in diameter, as were all other moving parts. Later engines of the same design have produced more power, are very efficient, and still being used to a limited extent.

The four-cylinder vertical engine was the first aviation engine to do real service. The airplane flown with so small an amount of power was large in wing area for the load carried, slow in speed, and sluggish in movement, judged by present standards. Such an airplane resembles the butterfly rather than the swallow. It is not like the successful fighting machine, yet will surely find place for peace usages.

Closely following this first type of engine came six-cylinder vertical and eight-cylinder V engines of 65 hp. and 75 hp. All of these were too light and frail for hard service. Minutes of flight were possible, but not hours, as now required. High-pressure lubrication to vital parts had not been developed. Valves failed because of inadequate cooling and material.

In Aug., 1908, the Wright Brothers made their first flight in France. Following this date, the French engineers developed airplanes and engines of various types that embodied the fundamentals demonstrated by the Wrights, so far as the airplane was concerned. The scientist contributed much to the art by working out the theory of the art of flying. A long step forward was taken in the succeeding years.

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* Presented at a meeting of the Mechanical and Engineering Section of the Franklin Institute.

Air-cooled engines of the radial rotating form were developed, then air-cooled and water-cooled vertical and fixed cylinders. These successive steps again repeated the steps taken by those who had developed the automobile and its engine: all were too frail and of small power. It seems safe to state that nothing as large as 100 hp. was reached or thought necessary. The Gnome radial rotating engine became most successful, and, as experience improved the skill of the aviator, the power of the engine grew gradually from 60 hp. up to 90 hp. Similarly the speed of the airplane increased up to 60 or 70 m.p.h., with slow speed or landing speed in the neighborhood of 40 m.p.h.

After a few years of this normal development, with reasonable progress relatively slow because of the enormous cost attending aircraft experiment, came the present European war. Then began a feverish and rapid development, during which rash moves were made and long chances of an engineering character were taken. How much the demands of war have advanced the art of aviation can only be guessed, but surely as much as a generation.

As soon as the absolute necessity of aircraft as a part of a modern army was demonstrated, the production of them was forced to the limit.

Extreme types are built and flown. Planes of small area, equipped with engines of large horsepower, which must be landed at 80 m.p.h., must be used. This type is the fighting craft that seeks altitudes above the hostile projectile danger zone (about 18,000 ft.), and higher yet in order to be able to swoop down on the slower plane or upon some less skillful aviator. One hundred horsepower is no longer enough for this light and agile airplane. An engine, eight-cylinder, V type, of 150 hp., is most popular now, but with a tendency toward, and small actual use of, 200 hp., yielding a speed of 140 m.p.h. and a climb of more than 1000 ft. per minute.

The only type of airplane used for war purposes, satisfied by an engine of 100 hp. or less, is the school machine, which carries teacher and student, tandem or side by side, in the body. Thousands of these are needed and being used in Europe. It is pleasing to know that one engine being built in the United States is giving excellent satisfaction in England for this purpose.

For large war craft, battleplanes so-called, more powerful engines are used. So far as known, this demand is met by engines of 250 to 350 hp. These aircraft carry bombs of explosives up to 1000 lb. in weight, and small defensive guns. They are not agile nor fast, and are defended by fast machines when possible to do so. They are the battleships of the air, defended by the torpedo-boat.

To produce this power, 12 and 18 cylinders are used. The latter is of the V type, with three rows of cylinders in place of two. It is new and said to be very successful. The power is transmitted to the propeller through gears, the propeller rotating about three-fifths engine speed, at about 1000 to 1200 r.p.m. Wherever possible, gearing is avoided because of the great weight added and increased mechanical difficulties. The difficulties surrounding the propeller problem also deter. The combination of much power and high speed tends to wreck propellers. There are many elements entering into this phase of the use of large powers not yet fully understood.

An obvious means to equip an airplane with more power is to use more than one engine unit. This is done and will be done, but there is a penalty attached to the plan. The ideal disposition of weight in an airplane is to have all concentrated at the center of gravity of the entire structure. A single engine unit approaches this condition as nearly as may be. Two units mounted out in the wings, away from the center of gravity, increase the inertia, decrease the agility and maneuvering quality very much. An airplane so equipped cannot quickly turn and twist to avoid the attack of the fast machine.

There will come a time when all engineering attention is not drawn to airplanes for war purposes. Then a type of plane will be developed that will not have speed, agility, and climbing power as its principal attributes. Much less power will fill this need, and a much more normal aircraft will result. Then the multiple unit plane will have a chance to develop.

Our present aircraft development is what the racing car has been to the automobile industry—a wonderful developer for normal product and usage. In time real manufacture will begin, prices will drop and popularity increase. Engines to meet such a purpose will develop rapidly. They will, as now, be highly refined as to their essential functions, but of ordinary construction as to the non-vital functions. At present the extreme of design, workmanship, and material is the aim for all parts. The art is too young to permit any other procedure.

Engine Design

The desired engine must be light, but it must be reliable. It must be capable of continuous operation at very nearly full capacity for long periods. A 20,000-ft. climb requires that everything shall be perfect.

The periods of partial use and rest are short, as for a glide. The period of level flying is from 75 per cent full power to full power, at the desire of the operator. Pursuit or flight means full power, patrol or observation duty means less; but at no time does the usage approach that of the motor-car engine. The demand is even greater than that on the marine engine, which carries a very constant load; but the marine engine may be made heavy—the aviation engine must be light.

Experience has taught that lightness must be abandoned in favor of stiffness and strength for all vital parts, such as crankshaft, crank-base, main bearings, crank-pin and piston-pin bearings, and that all possible lightness must be gained by hollow construction in combination with materials most carefully chosen. Coupled with these features must be found most thorough oiling at high pressure, with oil led in a positive manner to all vital points. Much experimenting must be done, even after careful design, to arrive at a proper distribution of oil. Clearances, oil apertures and oil viscosity (hot) must be balanced.

Poppet valves must close on seats that are thoroughly cooled. Exhaust valves run cherry red hot at best. Preparations and detail of design must avoid warping and breakage.

Ignition is desired in complete duplicate for each cylinder. Magnetos must be coupled and driven in such a manner as to minimize vibration. Magneto difficulties have been of mechanical failure more than electrical, and the direct result of excessive strains due to rigid driving couplings. Wiring must be carefully conducted and fastened to prevent failure from chafing, following excessive vibration.

Spark-plugs have been the cause of more trouble and uncertainty than any other single item of aviation engine detail. The prime difficulty has been to keep the plug cool. A cool location must be provided in the design. The plug must not extend so far into the explosion chamber as to be seriously flame-swept, nor must it be deep in a hole or recess with delayed and irregular ignition. The plug itself must be gas-tight to prevent "blow by" and resulting overheat. The plug that satisfies the automobile engine will fail quickly under aviation service. This defect is more serious than appreciated, and must be guarded against. It is not easy to locate, as often assumed. Frequent change of plugs is now resorted to in the interest of reliability. Close attention to the foregoing and simple items will surely increase spark-plug life and engine reliability.

There is no more mystery about an aviation engine than about any other, when the real truth is known.

One hundred and fifteen pounds per square inch mean effective pressure is very hard to handle in connection with a light bit of construction. This pressure is needed to yield the horsepower per unit volume.

The perfect balance of moving parts is necessary. The airplane structure is very sensitive to vibration, and the occupants are seriously disturbed by an engine not functioning smoothly.

Perfect distribution of gas to give uniform explosions is a requisite. The delicate engine structure fails rapidly under the influence of irregular impulses. Carburetor parts, thin aluminum castings, wiring, gasoline tanks and piping, magneto, radiator, and propellers all fail to a serious extent in the presence of vibration.

Simplicity of design, with the smallest possible number of parts, must be the aim. Each additional screw, joint, part, or accessory increases chance of trouble in the air. The failure of such detail may cause a forced landing accident.

The fire risk may be minimized by such design of engine compartment as will promote the movement of a large volume of air in and out of the engine compartment—in such a way as to carry gasoline or gas clear of the airplane body and operator's cock-pit. Without an accumulation of gasoline the danger is small.

Engine Workmanship

The keynote of this feature is that quality must come first, cost second or last. Time must be taken to arrive at the desired accuracy or finish. Time and money must be spent to balance reciprocating parts. A limit of one per cent difference of weight for all pistons and rods in an engine is required in some cases. Exact balance of all pairs is required.

Piston rings must be tight as the result of perfect fit and bearing. Many rings must be discarded to get perfect sets. Rings good enough for motor-car engines will not do the work in aviation engines.

The engine must not throw oil from any joint, valve stem, gear-box, or pipe. Oil so thrown may easily cloud the goggles of the pilot. Only the closest of fits will achieve such oil-tightness.

Castings, whether aluminum or iron, must be true and of even wall thickness and of extreme lightness. Many rejections must be made to get the uniformity needed. Such rejections should be figured by those accepting engine casting orders. The best of pattern equipment and forging dies must be furnished for a comparatively small number of pieces. This adds materially to the cost of a part, but is necessary to attain workmanship of aviation engine quality.

Machine tools, fixtures, and methods must be such as to produce absolute accuracy, regardless of cost. "Quality first" should be the watchword in aviation, not "Safety first," because high quality means safety.

It is very hard to create this atmosphere among business men, superintendents, foremen, and workmen, who have always been obliged to keep in mind the cost and selling price of a product to meet competition. There is no competition in airplane engines yet. The art is too new. Performance comes first. Only the best in design, material, and workmanship will suffice.

It is possible that too much time and money are being spent; but at this time experience has not been great enough to be certain of this. Continued use over a long period of time will determine. During the youth of the industry is not the time to take a chance.

Quality and safety come first.

Engine Materials

Excellent material is required for a motor-car engine which is rarely worked to anywhere near its limit of power. Take for an example a 40-hp. engine. It runs quietly about over roads nearly level, with liberal lubricant for the work being done and consuming hardly 25 per cent (10 hp.) of its rated power.

Under comparable conditions an airplane engine uses 75 per cent of its power. Lubrication must be perfect, not nearly so.

Further: a motor-car engine of 672 cu. in. capacity is given a normal rating of 65 hp. An aviation engine of the same volume is rated at 154 hp. As a motor-car engine not over 25 per cent, or 16 hp., would be ordinarily used, but as an aviation engine not less than 75 per cent, or 114 hp., would be habitually used, a ratio of about 7 to 1.

In addition, the aviation engine is built as light as possible, say about one-half the weight for a given piston displacement. Roughly speaking, this represents a punishment of material within the aviation engine fourteen times as severe as that in the motor-car engine.

The present life of an aviation engine indicates severe punishment. Up to the time when a complete overhaul is necessary this life is about fifty hours at, say, 100 m.p.h., or a total of 5000 miles. A motor-car engine runs about 25,000 miles up to the time when an overhaul repair is necessary. The speed cannot average over 25 m.p.h. This means 1000 hours' operation, or twenty times that of the aviation engine.

A severe test of endurance for the motor-car engine under shop or laboratory conditions, and where destruction of the engine is invited and closely approached, is under a development of power of about 0.15 hp. per cubic inch displacement. It it considered a fine performance for a stock motor-car engine to last 300 hours under this load. The aviation engine must do not less than this at any time and with 100 per cent score. Otherwise the engine is not a successful aviation engine.

These are rough comparisons, but they show the relative severity of work. To meet these severe conditions the very best of steel for each engine part must be used. "Best" means that money must not hinder, but high-priced steel is not sure to be best. The highest of technical skill must be utilized: first, to select the steel from chemical and physical soundness standpoints; second, to treat it in such a manner as to give the best possible endurance and the highest elastic limit consistent with the possibility of machining. Here, again, money must not be a consideration. Slow methods may be necessary to work the material.

The crank-shaft of a motor-car engine is usually so large and heavy as to permit the use of steel having an elastic limit of about 70,000 lb. per sq. in. and with a physical structure not very highly refined by heat treatment. Experience has shown this to be good practice.

The crankshaft of an airplane engine may be more in diameter, but hollow to such an extent as to demand the highest elastic limit that can be machined, say from 120,000 to 140,000 lb. per sq. in., with a reduction of area, denoting the highest refinement of grain, of 50 per cent or more.

The lighter parts of a motor-car engine, such as valve rocker arms, are given a toughening treatment for a fair forging steel, say 60,000 to 80,000 lb. per sq. in. elastic limit. The rocker arms of an airplane engine are so light and delicate as to require a fine alloy steel most carefully treated to give resistance to vibration and alternate stress. The elastic limit should also be in the neighborhood of 130,000 lb. per sq. in. This, coupled with hardness at certain points, brings additional care and expense.

A decade hence there will exist an accumulation of empirical knowledge. Extremes will then be less common or else the extreme of today will be the commonplace of the future. Experience will repeat in aviation as in many other industries and arts.

Book Review

"DYKE'S AUTOMOBILE ENCYCLOPEDIA," A. L. Dyke, St. Louis. (Sixth Edition, 1918. $3, 900 pp., 3392 ill.)

Dyke's Automobile Encyclopedia is a book well deserving the attention of the aviator and the air mechanic for, although it does not specifically deal with aviation engines it treats the subject of the internal combustion engine in such a comprehensive manner that the working of the stationary aviation engine becomes self-explanatory. The fact that the Signal Corps Aviation School at San Diego, Cal., is using this book in its course of instruction particularly recommends Dyke's Automobile Encyclopedia to the aeronautical student.

The book is not what one might term an encyclopedia in the true sense of the word, yet it is one of the most complete reference works on automobiles published; any subject, trouble, remedy or repair one can think of can be found in the 6000 lines of index.

The repair subject is, perhaps, the most interesting part of the book. There are 1189 illustrations and 154 pages devoted to this subject alone. Other instructions cover such subjects as: how to build a repair shop for home or business, and how to equip the shop from small tools to regrinding cylinders. Tire repairs, welding, battery charging, etc., are thoroughly treated. The reader is taught how to use tools; how to cut threads; how to distinguish S. A. E. and U. S. S. threads; how to use and read measuring instruments; how to solder, case harden and repair radiators; how to redesign old cars; how to straighten frames, fenders, etc.

The subject of oxy-acetylene welding is very complete and fully illustrated. The instructions on ignition systems cover the entire field and in a simplified manner which anyone can understand. Instructions on the electric starting, generating and lighting are simplified with hundreds of clear illustrations of diagrams. There are 775 illustrations and 279 pages devoted to electric matters, including the storage battery and ignition subjects. In addition there are two supplements on the Ford and Packard cars, with 91 pages and 332 illustrations, a part of which are printed in two colors.

International Aircraft Standards

(Continued from last issue)

3N16--Specifications for Aluminum Alloy Sheet

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The aluminum alloy of these sheets shall be made from standard No. 1 aluminum conforming to I. A. S. B. specification 2N1. The specific gravity of the aluminum alloy shall not be greater than 2.85.

MANUFACTURE.—3. No scrap shall be used other than that produced in the manufacturer's own plants and which is of the same composition as the material specified.

WORKMANSHIP AND FINISH.—4. *(a)* All sheets shall be sound, flat, free from buckles, seams, discoloration or other surface defects.

(b) Any sheet may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously passed inspection; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—5. The sheets may be specified in either of two tempers as desired. Specimens cut in any direction from the sheets must have the following physical properties:

Tensile Test.—*(a)*

	Temper 1		Temper 2	
	Pounds per square inch	Kilograms per square millimeter	Pounds per square inch	Kilograms per square millimeter
Minimum tensile strength........	55,000	38.6	50,000	35.1
Minimum yield point..........	25,000	17.5	25,000	17.5
Minimum elongation in 2 inches.	15 per cent.		20 per cent.	

Bend Test.—*(b)* Strips cut from sheets of either temper shall withstand being bent cold through an angle of 180° around a diameter equal to four times the thickness of the sheet.

SELECTION OF TEST SPECIMENS.—6. Test specimens shall be cut from a sheet selected from each 500 pounds or individual lot submitted of less than 500 pounds.

DIMENSIONS AND TOLERANCES.—7. The tolerances upon sheets shall be those given in the table below:

Brown & Sharpe gauge	Thickness *Inch*	Tolerance *Inch*	Thickness *Millimeters*	Tolerance *Millimeter*
10-17	0.1019-0.0453	±0.003	2.588-1.151	0.070
18-26	.0403- .0159	± .002	1.024- .404	.051

DELIVERY, SHIPPING AND PACKING.—8. The sheets shall be delivered in boxes of gross weight not greater than 220 pounds (100 kg.).

3S29—Specifications for Annealed Carbon Steel Forgings and Stampings

(65,000 Pounds per Square Inch Tensile Strength.)

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The steel from which these forgings or stampings are made shall conform to I. A. S. B. specification 3S2; the steel has the following comparison:

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum
1035	0.30-0.40	0.50-0.80	0.045	0.050

MANUFACTURE.—3. *Heat Treatment.*—*(a)* All forgings or stampings shall be annealed.

(b) Forgings or stampings which fail to meet the physical tests may, at the option of the purchaser, be reannealed.

WORKMANSHIP AND FINISH.—4. *(a)* The forgings and stampings must be uniform in quality, free from pipes, laps, cracks, twists, seams, and must have a workmanlike finish.

(b) A forging or stamping may be rejected at any time because of injurious defects or faults which are revealed by manufacturing operations, notwithstanding that it has previously passed inspection. Such rejected forgings or stampings shall be returned to the manufacturer at his expense. This clause shall not apply to materials fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—5. *(a)* The heat-treated forgings or stampings shall have the following physical properties:

Tensile Test.—*(b)*

	Pounds per square inch	Kilograms per square millimeter
Minimum tensile strength......	65,000	45.7
Minimum yield point..........	36,000	25.3
Minimum elongation in 2 inches or proportional gauge length..	25 per cent.	
Minimum reduction of area....	50 per cent.	

Impact Test.—(c) When impact-testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture in foot-pounds (or kilogrammeters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Brinell Hardness Test.—*(d)* The Brinell hardness test shall be made after the tensile test has been met. The procedure shall be as follows:

(1) Forgings for a Prolongation for Tensile Test Specimens: A hardness test shall be made on the prolong and on the opposite end of the forging. The hardness values obtained must agree within 3 per cent. Hardness values of other forgings in the same lot must agree with the average of the two test values within 3 per cent.

(2) Forgings or Stampings Without Prolongations: Hardness tests shall be made on the forgings or stampings selected for the tensile test and must agree within 3 per cent. The hardness values of other forgings or stampings in the same lot must agree with the average of the values so obtained within 3 per cent.

(3) Forgings or Stampings from Which a Tensile Test Specimen Can Not Be Procured: A hardness test shall be made on the forged bar representing the forgings or stampings. The hardness values of the forgings or stampings in the lot must agree with that obtained on the bar within 3 per cent.

SELECTION OF TEST SPECIMENS.—6. *(a) Forgings or Stampings Weighing 6 Pounds (3.7 kg.) or Over.*—If desired, each piece may be required to have a prolongation for the tensile test. Two per cent of the forgings or stampings in each lot shall be subjected to the tensile test unless a tensile test is specified for each forging or stamping.

(b) Forgings or Stampings Weighing Less than 6 Pounds (3.7 kg.) and of Suitable Section for Securing a Tensile Test Specimen.—Two per cent of the forgings or stampings shall be taken for the tensile test.

(c) Forgings or stampings from which no tensile test specimen can be secured shall be represented by a bar forged from the same material and to the ruling section of the forgings or stampings in the lot. The bar must be heat-treated with the lot which it represents.

(d) At least one tensile test shall be made for each lot of 50 forgings or stampings.

(e) A hardness test may be required on each forging or stamping offered. At least 25 per cent of the pieces in each lot shall be tested for hardness.

(f) All the forgings or stampings in a lot shall be heat treated at the same time, and if possible shall be from the same heat of steel.

DIMENSIONS AND TOLERANCES.—7. The forgings and stampings shall conform to the dimensions on the drawings within the tolerances specified. Surfaces which are to be machined shall admit of finishing to the required dimensions without leaving trace of the original surface.

PACKING, SHIPPING, AND DELIVERY.—8. Small forgings or stampings shall be boxed for shipment; the gross weight of individual boxes must not exceed 220 pounds (100 kg.). Each kind and lot of forgings or stampings shall be kept separate as inspected.

3S30—Specifications for Heat-Treated Carbon Steel Forgings and Stampings

(80,000 Pounds per Square Inch Tensile Strength.)

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The steel from which these forgings or stampings are made shall conform to I. A. S. B. specification 3S2; the steel has the following composition:

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum
1035	0.30-0.40	0.50-0.80	0.045	0.050

MANUFACTURE.—3. *Heat Treatment.*—*(a)* Forgings or stampings should be annealed before heat treatment.

(b) Forgings or stampings which fail to meet the physical tests may, at the option of the purchaser, be reheat treated.

WORKMANSHIP AND FINISH.—4. *(a)* The forgings and stampings must be uniform in quality, free from pipes, laps, cracks, twists, seams, and must have a workmanlike finish.

(b) A forging or stamping may be rejected at any time because of injurious defects or faults which are revealed by manufacturing operations, notwithstanding that it has previously passed inspection. Such rejected forgings or stampings shall be returned to the manufacturer at his expense. This clause shall not apply to materials fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—5. *(a)* The heat-treated forgings or stampings shall have the following physical properties:

Tensile Test.—*(b)*

	Pounds per square inch	Kilograms per square millimeter
Minimum tensile strength......	80,000	56.2
Minimum yield point........	60,000	42.2
Minimum elongation in 2 inches or proportional gauge length...	22 per cent.	
Minimum reduction of area.....	45 per cent.	

Impact Test.—*(c)* When impact-testing machines of the pendulum type are available tests shall be carried out if required to determine the specific impact work of rupture in foot-pounds (or kilogrammeters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Brinell Hardness Test.—(*d*) The Brinell hardness test shall be made after the tensile test has been met. The procedure shall be as follows:

(1) Forgings with a Prolongation for Tensile Test Specimens: A hardness test shall be made on the prolong and on the opposite end of the forging. The hardness values obtained must agree within 3 per cent. Hardness values of other forgings in the same lot must agree with the average of the two test values within 3 per cent.

(2) Forgings or Stampings Without Prolongations: Hardness tests shall be made on the forgings or stampings selected for the tensile test and must agree within 3 per cent. The hardness values of other forgings or stampings in the same lot must agree with the average of the values so obtained within 3 per cent.

(3) Forgings or Stampings from Which a Tensile Test Specimen Can Not Be Procured: A hardness test shall be made on the forged bar representing the forgings or stampings. The hardness values of the forgings or stampings in the lot must agree with that obtained on the bar within 3 per cent.

SELECTION OF TEST SPECIMENS.—6. (*a*) *Forgings or Stampings Weighing 6 Pounds (3.7 kg.) or Over.*—If desired, each piece may be required to have a prolongation for the tensile test. Two per cent of the forgings or stampings in each lot shall be subjected to the tensile test, unless a tensile test is specified for each forging or stamping.

(*b*) *Forgings or Stampings Weighing Less Than 6 Pounds (3.7 kg.) and of Suitable Section for Securing a Tensile Test Specimen.*—Two per cent of the forgings or stampings shall be taken for the tensile test.

(*c*) Forgings or stampings from which no tensile test specimen can be secured, shall be represented by a bar forged from the same material and to the ruling section of the forgings or stampings in the lot. The bar must be heat treated with the lot which it represents.

(*d*) At least one tensile test shall be made for each lot of 50 forgings or stampings.

(*e*) A hardness test may be required on each forging or stamping offered. At least 25 per cent of the pieces in each lot shall be tested for hardness.

(*f*) All the forgings or stampings in a lot shall be heat treated at the same time, and if posible shall be from the same heat of steel.

DIMENSIONS AND TOLERANCES.—7. The forgings and stampings shall conform to the dimensions on the drawings within the tolerances specified. Surfaces which are to be machined shall admit of finishing to the required dimensions without leaving trace of the original surface.

PACKING, SHIPPING, AND DELIVERY.—8. Small forgings or stampings shall be boxed for shipment; the gross weight of individual boxes must not exceed 220 pounds (100 kg.). Each kind and lot of forgings or stampings shall be kept separate as inspected.

3S31—Specifications for Heat-Treated Carbon Steel Forgings and Stampings

(95,000 Pounds per Square Inch Tensile Strength.)

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The steel from which these forgings or stampings are made shall conform t o I. A. S. B. specifications 3S35; the steel shall have the following composition:

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum
1045	0.40–0.50	0.50–0.80	0.045	0.050

MANUFACTURE. — 3. *Heat Treatment.*—(*a*) Forgings or stampings should be annealed before heat treatment.

(*b*) Forgings or stampings which fail to meet the physical tests may, at the option of the purchaser, be reheat treated.

WORKMANSHIP AND FINISH. — 4. (*a*) The forgings and stampings must be uniform in quality, free from pipes, laps, cracks, twists and seams, and must have a workmanlike finish.

(*b*) A forging or stamping may be rejected at any time because of injurious defects or faults which are revealed by manufacturing operations, notwithstanding that it has previously passed inspection. Such rejected forgings or stampings shall be returned to the manufacturer at his expense. This clause shall not apply to materials fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—5. (*a*) The heat-treated forgings or stampings shall have the following physical properties:

Tensile Test.—(*a*)

	Pounds per square inch	Kilograms per square millimeter
Minimum tensile strength......	95,000	65.8
Minimum yield point..........	70,000	49.2
Minimum elongation in 2 inches or proportional gauge length...	18 per cent.	
Minimum reduction of area.....	45 per cent.	

Impact Test.—(*c*) When impact-testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture in foot-pounds (or kilogrammeters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Brinell Hardness Test.—(*d*) This test shall be made after the tensile test has been met. The procedure shall be as follows:

(1) Forgings with a Prolongation for Tensile Test Specimens: A hardness test shall be made on the prolong and on the opposite end of the forging. The hardness values obtained must agree within 3 per cent. Hardness values of other forgings in the same lot must agree with the average of the two test values within 3 per cent.

(2) Forgings or Stampings without Prolongations: Hardness tests shall be made on the forgings or stampings selected for the tensile test and must agree within 3 per cent. The hardness values of other forgings or stampings in the same lot must agree with the average of the values so obtained within 3 per cent.

(3) Forgings or Stampings from Which a Tensile Test Specimen Can Not Be Procured: A hardness test shall be made on the forged bar representing the forgings or stampings. The hardness values of the forgings or stampings in the lot must agree with that obtained on the bar within 3 per cent.

SELECTION OF TEST SPECIMENS.—(6) *Forgings or Stampings Weighing 6 Pounds (3.7 kg.) or Over.*—(*a*) If desired, each piece may be required to have a prolongation for the tensile test. Two per cent of the forgings or stampings in each lot shall be subjected to the tensile test unless a tensile test is specified for each forging or stamping.

(*b*) *Forgings or Stampings Weighing Less Than 6 Pounds (3.7 kg.) and of Suitable Section for Securing a Tensile Test Specimen.*—(*b*) Two per cent of the forgings or stampings shall be taken for the tensile test.

(*c*) Forgings or stampings from which no tensile test specimen can be secured, shall be represented by a bar forged from the same material and to the ruling section of the forgings or stampings in the lot. The bar must be heat-treated with the lot which it represents.

(*d*) At least one tensile test shall be made for each lot of 50 forgings or stampings.

(*e*) A hardness test may be required on each forging or stamping offered. At least 25 per cent of the pieces in each lot shall be tested for hardness.

(*f*) All the forgings or stampings in a lot shall be heat treated at the same time, and if possible shall be from the same heat of steel.

DIMENSIONS AND TOLERANCES.—7. The forgings and stampings shall conform to the dimensions on the drawings within the tolerances specified. Surfaces which are to be machined shall admit of finishing to the required dimensions without leaving trace of the original surface.

PACKING, SHIPPING, AND DELIVERY.—8. Small forgings or stampings shall be boxed for shipment; the gross weight of individual boxes must not exceed 220 pounds (100 kg.). Each kind and lot of forgings or stampings shall be kept separate as inspected.

3N10—Specifications for Babbitt Metal for Bronze-Backed Bearings

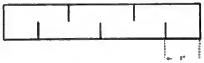
GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The composition of the material shall be as follows:

Constituent.	Desired.	Allowable variation.
	Per cent.	*Per cent.*
Tin..............	91 00	90–92
Antimony..........	4 50	4–5
Copper........	4 50	4–5
Lead, maximum.......	.20	....

SAMPLE FOR ANALYSIS.—3. (*a*) The inspector shall select one ingot from each lot of 25. The manufacturer shall melt this ingot in a clean ladle and cast therefrom one or more sample bars 6 in. long, 1 in. wide, and not more than ¼ in. thick.

(*b*) Saw cuts shall be made in each sample bar, as shown in the diagram below. The cuttings shall be thoroughly mixed and must be free from iron and dust. Samples for analysis shall be taken from the mixed cuttings.



MANUFACTURE.—4. (*a*) The babbitt metal shall be made from lake or electrolytic copper conforming to the I. A. S. B. specification 2N2 and from the best commercial grades of tin and antimony.

(*b*) No scrap shall be used other than that produced in the manufacturers' own plants and which is of the same composition as the material specified.

3S32—Specifications for Heat-Treated Alloy Steel Forgings and Stampings

(100,000 Pounds per Square Inch Tensile Strength.)

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The steel from which these forgings or stampings are made shall conform to I. A. S. B. specification 3S3.

MANUFACTURE.—3. *Heat Treatment.*—(*a*) Forgings or stampings should be annealed before heat treatment.

(*b*) Forgings or stampings which fail to meet the physical tests may, at the option of the purchaser, be reheat treated.

WORKMANSHIP AND FINISH.—4. (*a*) The forgings and stampings must be uniform in quality, free from pipes, laps, cracks, twists, and seams, and must have a workmanlike finish.

(*b*) A forging or stamping may be rejected at any time because of injurious defects or faults which are revealed by manufacturing operations, notwithstanding that it has previously passed inspection. Such rejected forgings or stampings shall be returned to the manufacturer at his expense. This clause shall not apply to materials fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—5. (*a*) The heat-treated forgings or stampings shall have the following physical properties:

Tensile Test.—(*b*)

	Pounds per square inch	Kilograms per square millimeter
Minimum tensile strength......	100,000	70.3
Minimum yield point..........	80,000	56.2
Minimum elongation in 2 inches or proportional gauge length..	20 per cent.	
Minimum reduction of area.....	50 per cent.	

Impact Test.—(*c*) When impact-testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture in foot-pounds (or kilogram-meters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Brinell Hardness Test.—(*d*) The Brinell hardness test shall be made after the tensile test has been met. The procedure shall be as follows:

(1) Forgings with a Prolongation for Tensile Test Specimens: A hardness test shall be made on the prolong and on the opposite end of the forging. The hardness values obtained must agree within 3 per cent. Hardness values of other forgings in the same lot must agree with the average of the two test values within 3 per cent.

(2) Forgings or Stampings without Prolongations: Hardness tests shall be made on the forgings or stampings selected for the tensile test and must agree within 3 per cent. The hardness values of other forgings or stampings in the same lot must agree with the average of the values so obtained within 3 per cent.

(3) Forgings or Stampings from which a Tensile Test Specimen Can Not Be Procured: A hardness test shall be made on the forged bar representing the forgings or stampings. The hardness values of the forgings or stampings in the lot must agree with that obtained on the bar within 3 per cent.

SELECTION OF TEST SPECIMENS.—6. *Forgings or Stampings Weighing 6 Pounds (3.7 kg.) or Over.*—(*a*) If desired, each piece may be required to have a prolongation for the tensile test. Two per cent of the forgings or stampings in each lot shall be subjected to the tensile test, unless a tensile test is specified for each forging or stamping.

Forgings or Stampings Weighing Less than 6 Pounds (3.7 kg.) and of Suitable Section for Securing a Tensile Test Specimen.—(*b*) Two per cent of the forgings or stampings shall be taken for the tensile test.

(*c*) Forgings or stampings from which no tensile test specimen can be secured shall be represented by a bar forged from the same material and to the ruling section of the forgings or stampings in the lot. The bar must be heat treated with the lot which it represents.

(*d*) At least one tensile test shall be made for each lot of 50 forgings or stampings.

(*e*) A hardness test may be required on each forging or stamping offered. At least 25 per cent of the pieces in each lot shall be tested for hardness.

(*f*) All the forgings or stampings in a lot shall be heat treated at the same time, and if possible shall be from the same heat of steel.

DIMENSIONS AND TOLERANCES.—7. The forgings and stampings shall conform to the dimensions on the drawings within the tolerances specified. Surfaces which are to be machined shall admit of finishing to the required dimensions without leaving trace of the original surface.

PACKING, SHIPPING, AND DELIVERY.—8. Small forgings or stampings shall be boxed for shipment; the gross weight of individual boxes must not exceed 220 pounds (100 kg.). Each kind and lot of forgings or stampings shall be kept separate as inspected.

3S33—Specifications for Heat-Treated Alloy Steel Forgings and Stampings

(120,000 Pounds per Square Inch Tensile Strength.)

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The steel from which these forgings or stampings are made shall conform to I. A. S. B. specification 3S4.

MANUFACTURE.—3. *Heat Treatment.*—(*a*) Forgings or stampings should be annealed before heat treatment.

(*b*) Forgings or stampings which fail to meet the physical tests may, at the option of the purchaser, be reheat treated.

WORKMANSHIP AND FINISH.—4. (*a*) The forgings and stampings must be uniform in quality, free from pipes, laps, cracks, twists, and seams, and must have a workmanlike finish.

(*b*) A forging or stamping may be rejected at any time because of injurious defects or faults which are revealed by manufacturing operations, notwithstanding that it has previously passed inspection. Such rejected forgings or stampings shall be returned to the manufacturer at his expense. This clause shall not apply to materials fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—5. (*a*) The heat-treated forgings or stampings shall have the following physical properties:

Tensile Test.—(*b*)

	Pounds per square inch	Kilograms per square millimeter
Minimum tensile strength......	120,000	84.3
Minimum yield point..........	95,000	66.8
Minimum elongation in 2 inches or proportional gauge length..	18 per cent.	
Minimum reduction of area.....	50 per cent.	

Impact Test.—(*c*) When impact-testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture in foot-pounds (or kilogram-meters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Brinell Hardness Test.—(*d*) The Brinell hardness test shall be made after the tensile test has been met. The procedure shall be as follows:

(1) Forgings with a Prolongation for Tensile Test Specimens: A hardness test shall be made on the prolong and on the opposite end of the forging. The hardness values obtained must agree within 3 per cent. Hardness values of other forgings in the same lot must agree with the average of the two test values within 3 per cent.

(2) Forgings or Stampings without Prolongation: Hardness tests shall be made on the forgings or stampings selected for the tensile test and must agree within 3 per cent. The hardness values of other forgings or stampings in the same lot must agree with the average of the values so obtained within 3 per cent.

(3) Forgings or Stampings from which a Tensile Test Specimen Can Not Be Procured: A hardness test shall be made on the forged bar representing the forgings or stampings. The hardness values of the forgings or stampings in the lot must agree with that obtained on the bar within 3 per cent.

SELECTION OF TEST SPECIMENS.—6. *Forgings or Stampings Weighing 6 Pounds (3.7 kg.) or Over.*—(*a*) If desired, each piece may be required to have a prolongation for the tensile test. Two per cent of the forgings or stampings in each lot shall be subjected to the tensile test, unless a tensile test is specified for each forging or stamping.

Forgings or Stampings Weighing Less than 6 Pounds (3.7 kg.) and of Suitable Section for Securing a Tensile Test Specimen.—(*b*) Two per cent of the forgings or stampings shall be taken for the tensile test.

(*c*) Forgings or stampings from which no tensile test specimen can be secured, shall be represented by a bar forged from the same material and to the ruling section of the forgings or stampings in the lot. The bar must be heat treated with the lot which it represents.

(*d*) At least one tensile test shall be made for each lot of 50 forgings or stampings.

(*e*) A hardness test may be required on each forging or stamping offered. At least 25 per cent of the pieces in each lot shall be tested for hardness.

(*f*) All the forgings or stampings in a lot shall be heat treated at the same time, and if possible shall be from the same heat of steel.

DIMENSIONS AND TOLERANCES.—7. The forgings and stampings shall conform to the dimensions on the drawings within the tolerances specified. Surfaces which are to be machined shall admit of finishing to the required dimensions without leaving trace of the original surface.

PACKING, SHIPPING, AND DELIVERY.—8. Small forgings or stampings shall be boxed for shipment; the gross weight of individual boxes must not exceed 220 pounds (100 kg.). Each kind and lot of forgings or stampings shall be kept separate as inspected.

Sheet Metal Workers' Tools and Machines

Descriptions and illustrations of tinsmiths' and sheet metal workers' tools and machines as they apply to the needs of the manufacturers of light metal parts of airplanes, are given in Catalog 16-A of the Peck, Stow & Wilcox Co., Southington, Conn.

It contains 270 pages, is attractively bound and indexed, and has more than 800 illustrations and much valuable data.

Digest of the Foreign Aeronautical Press

Flying (London), December 12, 1917

Traffic in the Clouds. By Claude D. Farmer.—As a passenger vehicle the airplane, and for that matter, the airship is a perfectly defensible proposition. No doubt can exist in any but the more sceptical minds that where speed is a *sine qua non* the air forms the solution of all the fretful delays and congestions of land travel and of the loss of time inherent to sea voyages. The development of a routine service of airplanes, even though the fares charged would be in excess of the first-class train fare of normal times, must lead to a remunerative source of traffic for the reason that there are many to whom the twenty-four hours of the day are all too short.

We need not, however, labor the point of passenger traffic by air. The proposition which we have set out to study is not that of human but of material cargoes. Here the future is neither so promising nor so easy to forecast.

The whole matter, in fact, turns upon the question of whether commerce involves any class of goods traffic which can be conveyed, let us say, more efficiently by the new system of transport than by the existing railway and steamship systems. The limiting condition is the fact that only certain classes of merchandise by reason of their bulk or weight, the latter factor being the determining one, lend themselves to conveyance by air. Of lighter than air machines, the L33 type of Zeppelin should allow useful loads—i. e. cargoes—up to five tons being borne. The maximum average speed attained by the Zeppelins is about 60 miles per hour. This is fast travel compared with what the goods train maintains as its average speed, and with the speed of the merchant ship. But at what cost is the consignee of the goods to pay for this speed? An initial capital investment of fully a quarter of a million sterling must be made good from the freight charges. Then there are the running expenses due to the fuel and oil consumption. To transport the five tons of goods over 1,000 miles in 16½ hours no less than 1,300 gallons of gasoline will be consumed. Now what, on the other hand, have the railway companies to offer? If speed be no object, there is the goods train, but since aerial locomotion makes its appeal on the grounds of speed, we must turn to the case of the passenger train in which five tons of parcels could be carried at almost the same speed and certainly far more cheaply than by the Zeppelin. The freight cost is much lower than the minimum rate at which the airship could compete upon a profit making basis, even supposing the efficiency of the gasoline engine to be enormously increased in the future. Marine transport is heavily at a disadvantage as regards speed, but against this there is the fact that it implies a cost per ton mile even lower than that for railway goods traffic.

The case for the large airplane is more hopeful, though scarcely promising enough to make one sanguine as to its utility in the immediate future. The best load carrying performance to date is probably about 2½ tons. A speed of 80 miles per hour may be assumed feasible with an engine power of 600 h.p. The capital cost of two such airplanes equivalent in carrying power to one Zeppelin would be but a fraction of the cost of one large airship. A saving would also be effected in aerodrome accommodation, not to mention the gain in utility for the conveyance of small packages presented by two airplanes as individual units contrasted with the single Zeppelin.

But even though the airplane is better than the airship on the score of cheapness of production per unit volume of traffic the freight charge per ton mile must still be higher than the prevailing parcels rate on the railways. The gain in speed, especially when one considers the time spent in collecting and distributing goods in large towns is not marked; certainly it is not decisive enough to compensate for the additional cost of transit, nor to justify traders in abandoning the established institution of the railways. Nor is the permanent way of the air likely to compete for many a long year with the mercantile marine, unless it be that international finance become so accelerated and intensified after the war as to demand the transference of specie from country to country in the minimum of time.

This last is, however, a special type of traffic. It is, in fact, in the administrative work of modern business rather than in the normal demands of material transport that one is tempted to forecast a lucrative field for the use of aircraft.

In commerce as in national government, there arise many classes of communication, the rapid transference of which from one office or one country to another implies extended business. Among men separated by hundreds of miles there are often multifarious papers to be signed and reports to be read with the least possible delay, and letters which it is not convenient to transmit by telegraph even when coded. It is for such urgent correspondence as this, smaller in volume than the usual post-bag for which railway transit is the cheaper system, that an aerial mail service might well be instituted. As a State enterprise the scheme could be organized to give such a service as frequent, and decidedly faster, than that afforded by the existing mail trains. Large firms might, indeed, under conditions where their business covered many parts of the country, combine a private mail service of their own with means for rapidly conveying members of their staff from one place of business to another. An aerial post between England and the Continent, and eventually between London and New York, would be an enterprise of incalculable value, as is evident when one realizes that the five days' voyage across the Atlantic could by air be made in two days or less. Such a performance as the latter is already under consideration as a practical possibility.

Flight (London), Dec. 6, 1917

The Danger of Over-Standardization (Editorial).—We are glad to hear that the Air Board has addressed a communication to the Aircraft Production Board of the United States on the subject of the danger arising out of over-standardization of aircraft, a subject to which attention has frequently been directed in these pages. As to the usefulness of standardization within limits there can be no two opinions, but it is quite possible for the keenness for output to work to our great disadvantage. In considering the problems attending the construction of aircraft, we have to keep it well before us that the design of today is likely to be rendered hopelessly obsolete by that of tomorrow, and it is thus folly of the worst description to put all our eggs into the one basket. We are not implying that that is the policy which is being pursued in America, but we do think there is a danger that our Allies' enthusiasm for manufacturing efficiency and huge outputs might tend to lead them a little astray. Evidently this view is shared to some extent by our own authorities, and hence the warning which is said to have been given. No undue importance need be attached to the fact that the Air Board has thought it necessary to give America what may really be called a friendly tip. There is certainly no divergence of opinion between us and our Allies regarding the future of war in the air. All that has happened is that a little advice, born of our greater experience of war, has been tendered by the one and accepted by the other in the spirit of absolute friendship.

The Aeroplane (London), Dec. 5, 1917

The Civil Aerial Transport Committee.—On Dec. 3, in reply to Mr. Pemberton Billing who asked to be informed about the progress made by the Civil Aerial Transport Committee, Mr. Bonar Law, Prime Minister of Great Britain stated in the House of Commons the following:

"During the last six months Lord Northcliffe, who was originally chairman, Major-General Brancker, Lord Montagu of Beaulieu, Mr. Claude Johnson, and Mr. Tyson Wilson have left the Committee in consequence of other duties, while Sir G. Perley, Major-General McCay, and Sir Mackenzie Chalmers have been added to the main Committee to represent the Dominion of Canada, the Commonwealth of Australia, and the Home Office respectively. Sir E. Morris, the Prime Minister of Newfoundland, is also joining the Committee. In addition, a number of gentlemen with special knowledge of the particular subjects of inquiry have been co-opted on the various sub-committees.

"It is proposed to continue the Committee in existence till it has presented its report."

News of the Fortnight

Department of Munitions Is Proposed

On Jan. 4 Senator George O. Chamberlain, of Oregon, introduced in the Senate a bill (S. 3311) to create a Department of Munitions, and on Jan. 7, Congressman William T. Borland of Missouri introduced a duplicate bill in the House of Representatives.

Discussing the intentions of the measure, Senator George O. Chamberlain of Oregon, Chairman of the Committee on Military Affairs, said, "The bill is intended to increase and expedite the supply of munitions of war. One great trouble with the war establishment as disclosed by the pending investigation has been a lack of co-ordination and the seeming impossibility of getting rid of circuitous methods of doing business. Until there can be co-ordination and methods more direct the United States will be groping in the dark for many months before we can place ourselves in proper fighting trim.

"This measure places all jurisdiction over munitions of war, which is defined at length in the bill and covering everything in one person, known as the Secretary of Munitions, subject to the direction, of course, of the President.

"It co-ordinates all of the bureaus, cuts red tape, does away with useless decisions which had tended only to hamper direct action, and gets to the heart of the whole situation. I believe if Congress can see its way to the enactment of this measure, and the proper man is placed at the head of the department of munitions, America will soon be occupying its proper place at the battle front. It will be noted that the measure is only in force during the continuance of the war, which brings it into existence."

Senator Chamberlain in reply to the questions of a representative of AVIATION AND AERONAUTICAL ENGINEERING stated in effect that his bill is designed to cover both the purchase and supply of airplanes and materials, the Liberty engine and whatever goes into their manufacture. As the Senator emphatically put it, "It covers everything."

The opinion in some quarters is that should this bill become a law, the powers of the Aircraft Board will be greatly curtailed, and that perhaps the Board will be entirely abolished. It is understood that this bill will be strongly pushed in the Senate for early passage.

Asks $50,000,000 for Aeronautic Bases

The expenditure of $50,000,000 for the construction of aeronautic bases in the United States and its territorial possessions is proposed in a report sent to Congress by Secretary of War Baker. The report contains an outline which the Secretary has in mind, and suggests that further information would be given to Congress in closed hearings of committees which handle the proposed appropriations.

The report does not disclose where it is proposed to locate the new bases. Here is the allotment suggested by Secretary Baker in disposing of the $50,000,000:

$24,000,000 for sixteen aeronautic stations in the United States.

$3,500,000 for twenty balloon stations in the United States.

$4,420,000 for aviation bases in Hawaii.

$5,420,000 for aviation bases in Panama.

$12,000,000 for equipment of these various bases.

Secretary Baker said no decision has been reached as to the locations.

S. A. E. to Discuss Motor Boats

A special meeting of the Society of Automotive Engineers for the consideration of subjects relating to motor boat matters will be held in New York on Friday evening, Jan. 25, during the week of the Annual Motor Boat Show, scheduled for Jan. 19-26. There will be afternoon and evening sessions, with a dinner sandwiched in between. The first session will be opened on Friday afternoon, Jan. 25. This meeting will be held at the S. A. E. headquarters, 29 West 39th Street. The dinner, and the evening session will be held at the Automobile Club of America, 247 West 54th Street.

Two Officers Made Military Aviators

Lieut-Cols. Virginus E. Clark and William L. Patterson have been recently rated as military aviators in the Aviation Section, Signal Corps of the United States Army.

Report of Council of National Defense

The annual report of the Council of National Defense covers its activities from its inception to the close of the fiscal year ending June 30, 1917. The permanent organization of the Council was not effected until March 3, of last year.

The complete report has not as yet been issued from the Government printing office, but in the summary prepared for the press, the policy of the Aircraft Production Board which has been superseded by the Aircraft Board, is of special interest to manufacturers of airplanes and aeronautical engines. The summary follows:

AIRCRAFT PRODUCTION BOARD

"The work of the Aircraft Board resolved itself into two main divisions, equipment for training purposes in this country and equipment for combat work in France. It was found that a very satisfactory training plane and motor had been developed by an American company, which had been tested and found satisfactory both by England and Canada.

"It was in the development of the program of combat, reconnaissance and bombing planes that the major difficulties were encountered. In all these forms of machine, the lack of previous American experience made it seem necessary to depend to a large extent on designs developed in the Allied countries or adaptations from these designs. In the production of engines there appeared to be an insuperable obstacle to produce foreign engines and translating them in the methods of American shop practice.

"It was this consideration that led to development of the composite international design known as the 'Liberty Engine,' so constructed and with its parts so standardized that it lends itself easily to quantity production with American shop methods.

"Among other features of the board's work, covered in the report, are the progressive development of the manufacturing resources of the country capable of being adapted to the manufacture of airplanes and the steps taken to convert them to that work, the general policy adopted of relying mainly on relatively few highly organized and manifestly capable establishments rather than scattering orders for planes and separate parts among a large number of small shops; this decision being accompanied by a careful inventory of the facilities for manufacture, particularly automobile plants: the steps taken to relieve the shortage in satins and linen, and the recommendations made as to forms of contract, the elimination of foreign royalties and other general assistance in developing business and industrial policy."

Airplane Mail Service

The act making appropriations for the service of the Post Office Department for the fiscal year ending June 30, 1919, and for other purposes (H. R. 7237), was passed by the House of Representatives on Dec. 14. It is now under consideration by the Committee on Post Offices and Post Roads of the Senate.

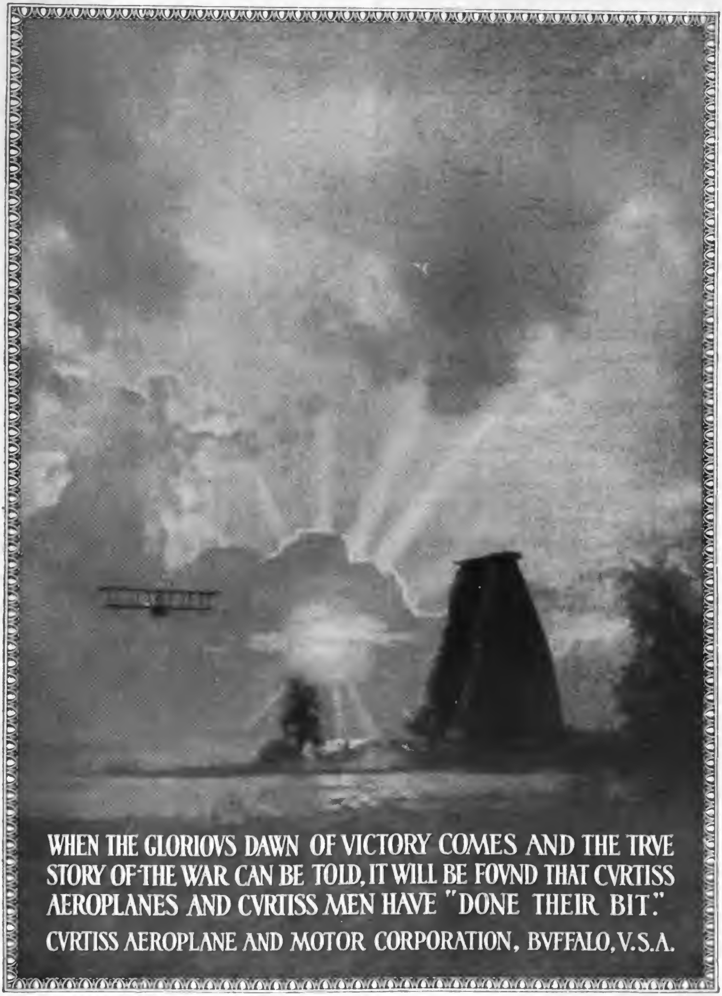
An item under the appropriation for the office of the second assistant postmaster general provides $1,185,000 for inland transportation by steamboat or other power-boat routes or by airplanes. The section reads:

"Out of this appropriation the Postmaster General is authorized to expend not exceeding $100,000 for the purchase, operation, and maintenance of airplanes for an experimental airplane mail service between such points as he may determine."

Government Is Using Motor Plant

A portion of the machinery and plant of the General Vehicle Co. of Long Island City, N. Y., which is being utilized to turn out the Gnome-monosoupape airplane engine, was recently taken over by the Government. The company makes the following announcement:

"With respect to certain rumors regarding the General Vehicle Co., Inc., it may be authoritatively stated that while a considerable portion of the Long Island City plant will be devoted to other work than manufacture of electric trucks, the General Vehicle Co., as well as its manufacture of electric trucks will continue utilizing such portions of the Long Island City plant as may be necessary for the purpose of continuing its business of nearly seventeen years."



WHEN THE GLORIOVS DAWN OF VICTORY COMES AND THE TRVE STORY OF THE WAR CAN BE TOLD, IT WILL BE FOVND THAT CVRTISS AEROPLANES AND CVRTISS MEN HAVE "DONE THEIR BIT."

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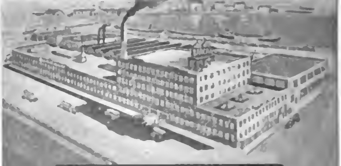

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A TWO-PLY BIASED FABRIC, COATED BETWEEN PLIES WITH A LIGHT, TOUGH LAYER OF PURE PARA RUBBER.

THIS FABRIC HAS BEEN DEVELOPED FROM YEARS OF LABORATORY EXPERIENCE, AND POSSESSES EVERY FEATURE AND QUALIFICATION NECESSARY TO A WELL-BALANCED PRODUCT, VIZ.:

STRONG
GAS-TIGHT
NEUTRAL, INVISIBLE COLOR
WITHSTANDS ALL WEATHER CONDITIONS
AND AGES WELL

MADE BY THE
WORLD'S LARGEST RUBBER COMPANY

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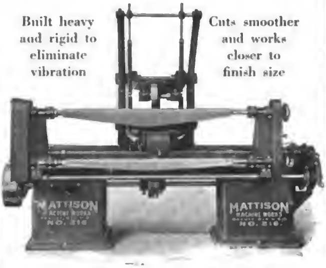
Special Aeroplane Strut Lathe

Built heavy and rigid to eliminate vibration

Cuts smoother and works closer to finish size



Mattison No. 216 Heavy Type Copying Lathe

This machine is in successful operation in some of the largest aeroplane factories in the country, on Interplane and Landing Gear Struts.

It is designed especially to meet the exacting needs of strut work, and is a great improvement over the ordinary Copying Lathe, both as to quality and quantity of output.

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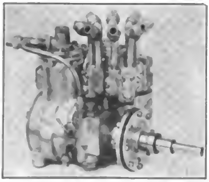

Starts the motor instantly regardless of weather conditions

Eliminates dangerous hand-cranking and other starting troubles

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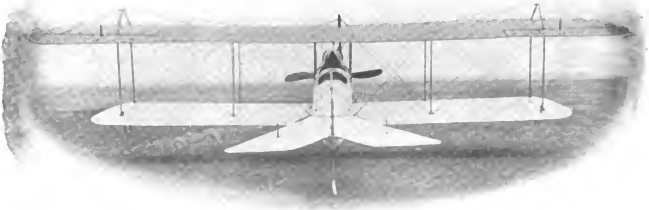

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III. *Tiemann-Grand Rapids Combination Kilns* (combining the scientific points of the Tiemann kiln with the practical experience of the Grand Rapids Veneer Works, subject to operation by either method).

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THOMAS-MORSE AIRCRAFT CORPORATION,
DAYTON-WRIGHT AIRPLANE COMPANY,
FISHER BODY CORPORATION,
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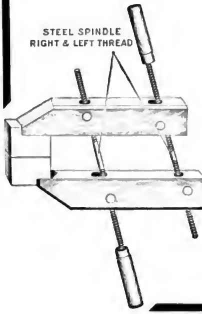

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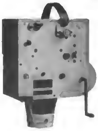

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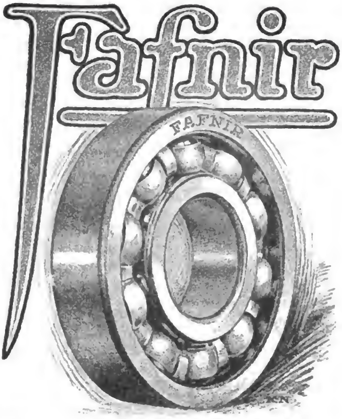

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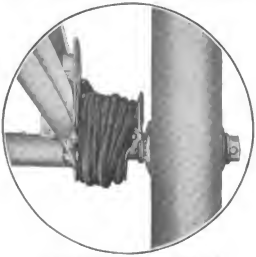

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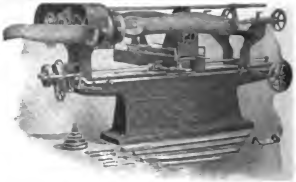

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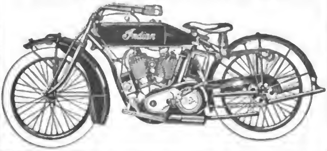

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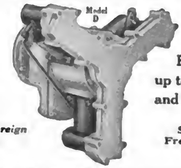

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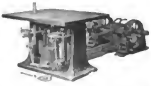

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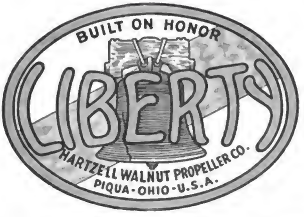
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Valentine & Co.
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Tioga Steel & Iron Co.
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Whitman & Barnes Mfg. Co.
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McBratney, Robt. & Co.
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Johns-Manville Co., H. W.
Pyrene Mfg. Co.

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Foxboro Co., The, Inc.
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Austin Co., The
Howell, Field & Goddard, Inc.
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Delatour, J.
Dutton, A. C. Lbr. Corp.
Ludlow, Israel
Mengel, C. C., & Bros. Co.

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Radium Dial Co.
Radium Luminous Material Corp.

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Defiance Machine Works
Rogers Construction Co.
Warner & Swasey Co.

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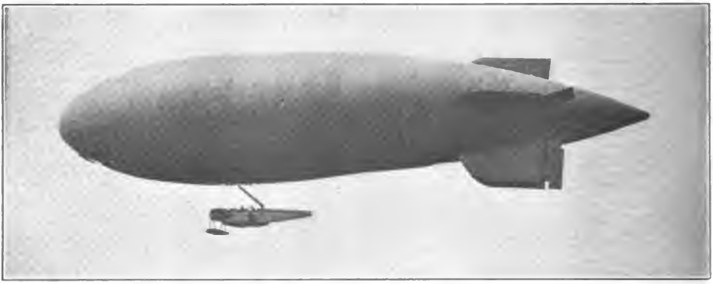

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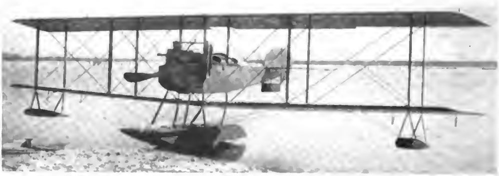

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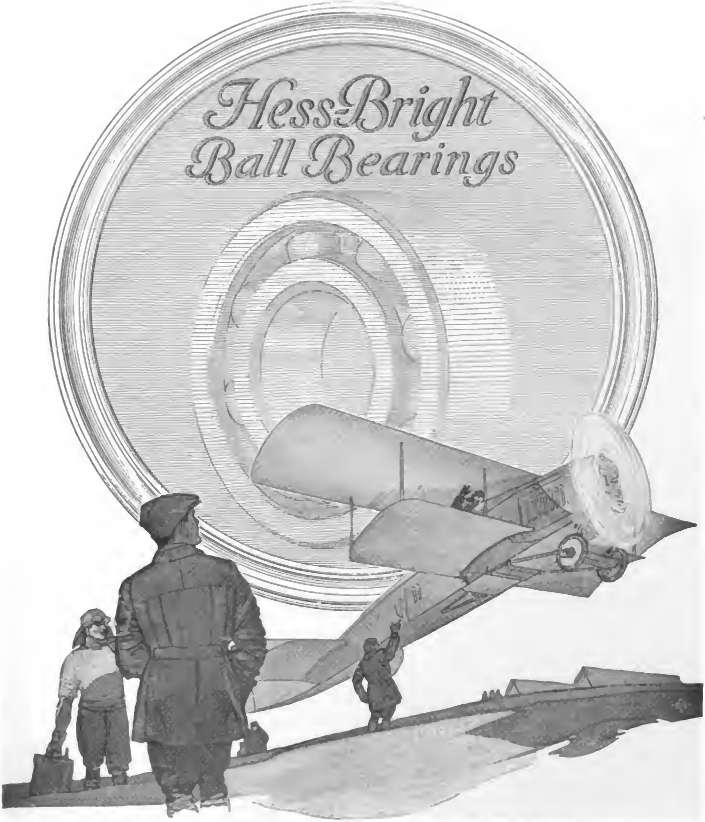

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